THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 38. Thursday, January 5, 1928. No. 594.

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telephone: Gerrard 3961 (4 lines).
Telegraphic Address: "Zacatecas, Rand, London."

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

JANUARY 7.

Lancashire Branch:—Ordinary meeting at Manchester. "Electric Melting of Non-Ferrous Metals," Paper by H. S. Primrose.

JANUARY 12.

London Branch:—Ordinary meeting in London. "Pattern Making," Paper by A. G. Furmston.

Introspective, 1928.

We have not this year in our review of the prospects for the next twelve months to envisage the effects of a prolonged period of deflation in the costs of the iron foundries' principal raw materials, as was the case last year. Cleveland No. 3 G.M.B., which had risen to 120s. per ton during the coal dispute, had by January 2 fallen to 85s., a figure still 15s. above the pre-strike figure. It was patent to the founders that the making of long-dated contracts was bad business, and throughout the year hand-to-mouth buying has been the rule. The price of pig-iron is now lower than that immediately preceding the coal dispute, and there now appears to be grounds for believing that the bottom has been reached, at least for the near future, and founders can buy their pig-iron with a reasonable amount of security that those who hold back will have to pay higher prices. We base our argument on the following factors:—(1) That the 4½ million tons of iron and steel which were imported during 1927 will be less this year and so create a greater demand for British material. This huge figure was due in some measure to contracts placed during 1926, and to the persistent underselling in most departments by Continental makers. (2) That the margin between British and Continental pig-iron prices has been narrowed almost to vanishing point. (3) That it seems probable that Germany will have to institute an 8-hour day throughout its metallurgical industries, with a consequent increase in selling price. (4) That cost of living is gradually but surely increasing in France, and the internal value of the franc is approaching its external since stabilisation was effected.

There is just one section of the foundry industry that these considerations affect somewhat differently, but still in the same general direction, that is our great cast-iron pipe concerns, who consume their own pig-iron, only selling the excess to the foundry industry when their own foundries are slack. Undoubtedly they require cheap pig to enable them to compete in the important export market. Last year we estimate the industry exported about 120,000 tons, at the average price of about £12 5s. per ton. Disregarding the 1926 figures as being abnormal, and comparing them with 1925, they show a 20 per cent. gain in weight (94,241 tons was the actual figure) at average loss of £2 per ton in price (£14 5s. 8d.). In spite of this 13 per cent. cut in two years, they have not yet succeeded in getting into the American Eastern Seaboard market, which is still held by the French producers. We believe that there are factors, other than that of price, and in authoritative quarters the opinion has been expressed that the grade of pipe accepted is of a standard lower than that made in Great Britain, and we wonder whether in working down to this particular quality prices could be reduced, though candidly we fail to see how this could be achieved without endangering the general high standard demanded in the home and other markets. However, we see no reason why the markets now filled by British material should not be retained and expanded, especially the Australian, where trading conditions have been poor during last year.

We are not quite so sanguine about the light castings industry. Primarily, the housing question is no longer acute, and is now showing a general slackening down. Furthermore, we are not satisfied with the progress made in the export market. We estimate that when the Board of Trade figures are published, covering last year, it will show that about 18,500 tons have been sold abroad, as compared with 19,668 and 19,131, for the years 1926 and 1925 respectively. Furthermore, an examination of the prices shows that for the years 1925 and 1926, averages were £45 12s. and £44 17s. per ton respectively, whilst it seems likely that last year the average will be considerably higher at £46 6s. per ton. This indicates that it has been with the lower-priced material on which ground has been lost. We are aware that certain sections of the industry are considering important improvements in their methods of manufacture, and it is to be hoped that these will reduce manufacturing costs sufficiently for them to meet successfully the competition of the export market. The Scottish foundries have had offered to them what is tantamount to a co-operative selling scheme by the Cleveland Ironmasters' Association, which body has opened up an office with the avowed object of selling direct to the consumer. We throw out the suggestion for what it is worth that the Scottish founders might do worse than to consider the opening up of a co-operative buying office on the lines of the Dutch iron founders.

With automobile founders, if reliance can be placed upon recent speeches made at company meetings, better trading conditions are to be expected. If they can but make a 5 per cent. gain on last year's showing there should be no shortage of work. The foundries catering for the steel industry, which after all produced 1½ million tons more than average pre-war output, should be reasonably busy, as the full effect of the rebate accorded to buyers of all British steel has not yet been fully felt.

Textile foundries catering for the flourishing artificial silk business have good prospects, but as the balance is engaged on cotton and wool we are afraid that recovery will be a slow matter, though even in this the bottom has been touched. The foundries catering for the mining world are assured of much better conditions, as undoubtedly the pits have recently spent as little as possible in new and replaced plant.

The marine and general engineering business is looking forward to maintaining last year's improved showing, whilst the electrical engineering foundries will be well satisfied if they can keep as well employed as they were during 1927.

Technically, 1928 is to be relatively quiet. An interesting convention is to be held at Leicester in June, under the presidency of Mr. S. H. Russell, a prominent local foundry owner. Years ago, Mr. Russell had the experience of organising a Convention in Leicester when Mr. Gimson was president. This was an outstanding success, and promises well for the coming year. He will have the help of Mr. Bunting, of Derby, who has also very considerable experience as an organiser. Also, there is to be a foundry convention in Spain in the spring. The headquarters are to be at Barcelona, and an important British delegation will undoubtedly participate. There will be no foundry exhibition in Europe.

XUM

Foundrymen are naturally keenly interested in the next few months, as they will show fairly plainly whether true co-operation is generally possible in British industry between the employers and the employed. If this can be consummated then it will be a real step towards the rationalisation of industry, which is so much desired by modern leaders of industrial thought.

Random Shots.

In view of the repeated statements as to the 1927 deficiency in sunshine, there is a peculiar irony in reading of the formal opening, not so very long ago, of the first run-ray clinic for miners at Mansfield. Under normal conditions, even in England, the miner is in a position quite different from the rest of us, and whatever one's opinion may be on the question of giving him sun-ray clinics, he certainly has a better claim to them than the butcher, the baker, and the candlestick maker—or the founder, for that matter. But it does look as if we should all be reduced very soon to sun-ray clinics if we are to have any sunshine at all—unless we are of the lucky ones of this world, now disporting themselves, as I have already lamented, amid the mountain snows of Switzerland or the palm-clad promenades of the Riviera.

* * *

Nor was the mood of gloom induced by these reflections materially lightened when I saw a little later a flaring headline in a Sunday paper: "Will the Sun ever Come Back?" or words to that effect. If the Press even is going to turn pessimist, surely all hope must be at an end. It would be wiser and far more beneficial to the community to adopt the method of the French Riviera authorities, who, it is rumoured (although I do not vouch for the truth of the rumour), have been censoring the weather reports lest they should discourage people from patronising their locality this season.

* * *

My recent remarks anent public dinners have brought me several stories, besides one or two that have come my way bearing a certain relationship to the burglar story already quoted in these pages. The best of the former batch relates to the American banquet hall on whose walls was posted the announcement: "The population of this country is 121,000,121. Only the odd 121 can make a decent speech. None of them lives in this town." . . . .

* * *

Of stories with a judicial flavour, my favourite is the one of the argument as to the relative powers of the clergy and the laity. "The judge," said the cleric, "can only say 'You be hanged,' whereas the bishop can say, 'You be damned.'" "Yes," replied the astute layman, "but when the judge says 'You be hanged' you generally are hanged."

* * *

There is another very nice one about the plaintiff who, when his name was called, stood up among the jury. "But, whatever are you doing there?" he was asked. "I was called to serve on the jury," he replied. "Well, but you can't possibly sit on the jury in your own case." "No," the plaintiff replied sadly, "I was afraid it was rather a bit of luck."

* * *

And there was a *bona-fide* juryman found to be missing during a trial. There was great consternation, until another juryman stood up and explained. "It's alright, my lord," he said, "he had to go and attend to some business of his own, but he left his vote with me in case we should get finished before he got back!"

* * *

We find that every good-class paper nowadays has a financial column, so we think we had better produce something of the sort.

FINANCIAL NOTES.

Market Report.—Gramophones continue to be a sound investment, and the breaking of fresh records daily is still a feature of the market. Artesian Wells are low, and appear likely to go lower. Fly Papers United and Treacle Preferred are distinctly sticky, and we should advise holding off. Artificial Hose show signs of rising still higher, and the makers continue to rise on the ladder. Pig-Irons are heavy. Beecham's and Three Star are being taken well, and the market has an astonishing capacity for absorption. Electricals are distinctly bright, being a shining feature in an otherwise dull market. The outlook for Plumbago is dark, but the issue is obscured by fluctuations due to profit-taking.

ANSWERS TO CORRESPONDENTS.

Speedy.—No, Spontaneous Cumbustions went off with a bang on opening, and have not since been heard of.

Suburban.—Yes, recent developments in Match shares are striking, but we advise you to play for safety.

Sur Fin.—No, Porcupines should not be touched.

Nuf Sed.—Yes, Fourwheel Breaks are likely to come to a sudden stop.

MARKSMAN.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Oil Sand and Motor Cylinders.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The article on "Oil Sand and Motor Cylinders" deserves attention, not only on account of the space it occupies in the official organ of the foundry trade, but also in deference to the author, who, in evident sincerity, has given much time and thought to the problem. It is possible, however, that the conclusions at which he has arrived may not be generally acceptable at the value he attaches to them, and it is more than possible that one may differ from them almost entirely.

In the first paragraph he states that it is necessary to add proportions of natural-bonded sand to make cores which are extremely large. To this statement I venture to give a flat denial, and I shall be happy to have the opportunity of supporting my opinion. Further, in the same paragraph, he states that, "No consideration is given to the use of clay additions." This is evidently regarded as important, being the only italicised phrase in the article. To me it is astounding, in these enlightened days, that anyone should even think of employing such an antiquated and dangerous method of overcoming the difficulty.

In the second paragraph, under the heading of "Rosin as an Agglomerant," the author states, *inter alia*, "in motor cylinder work, the greatest difficulty has been to produce a mixture having the requisite strength in the green state to enable the cores to stand, etc." Surely this is not so. It is perfectly simple to make a mixture to do this, and, further, to produce a good-looking core and sound casting from it. It is after the casting has been made that the trouble often arises in this class of work.

Just after the war I was requested by the principal of a firm manufacturing motor cars to examine some cylinders made for them by an outside firm. These, when cut into sections, showed parts of the cores still in the water passages, and I was told that every known device had been tried to remove the sand before the castings were sectioned.

I next visited the foundry where the castings were made and found an oil and rosin mixture was being used for bonding purposes. The green-bond was excellent, the baked cores all that could be desired—apparently—but, as stated above, the results were disastrous. No amount of academic or scientific discussion will overcome the fact that the antiquated rosin and oil mixture is hopelessly behind the times. So why worry about the comparative benefits of adding dry rosin or dissolved rosin to a "standard mixture." If the mixer is on top of its job the result should be the same, especially if to begin with the rosin is in the form of an "impalpable" powder. (I wonder how this powder is going to be obtained and maintained commercially and indefinitely in this form.)

The physical properties of the various substances will remain unchanged "In a solution," and the final bond will be the same whether the ingredients are mixed in one or two operations. Another result of using rosin is fairly certain, viz., sticky core boxes.

That Mr. West's mixer is inefficient seems to be proved conclusively by his Table II. How otherwise is one to account for the "Erratic results."

MILLING OF SAND.

We are invited to believe that the milling of core sand is not detrimental. Anyone who accepts this dictum and acts on it by using a mortar mill with heavy rollers will find to his cost that he has been misled, for they do undoubtedly grind the sand to flour, the time taken being proportionate to the weight of the rollers, unless the rollers are adjustable and can be easily raised off the pan bottom to any required height during the mixing process.

One can only suppose that Mr. West has permitted, unconsciously, some errors to creep in when he endeavours to prove by means of a graph that a paddle mixer has as great a grinding effect on sand as a mortar mill. It is unfortunate that an "old type" paddle mixer should have been selected for comparison, as there is a newer and better model available (the Fordath "Rotoil" mixer).

According to the graphs in Figs. 4 and 5, Mr. West actually obtains an increase in the grain size after mixing. It would be interesting to know his explanations.

In a perfect mixture the grains should be loose, but immediately assume a strong bond on being pressed together "by hand." In this mixture the coremaker gets uniformity throughout his cores. In a mixture bonded under heavy rollers the grains are too close to begin with in some parts and loose in others. In other words, the mixture as it leaves the mortar mill lacks uniformity, and this fact, quite apart from the presence of fine dust will be sufficient to prejudice the final core. A paddle mixer separates the grains whereas the other two mixers referred to compress them. One might as well compare the hay ready for carrying with that at the bottom of the haystack for density.

Mr. West insinuates that machinery manufacturers design, build and market machines without adequate trial, a cynical remark, involving methods I am sure never tolerated by Messrs. Leyland Motors, Limited, or they would not occupy their present position of eminence. Surely a totally unjustified and unwarrantable assumption. For example, the machine suggested above was working under ordinary foundry conditions for twelve months with the sole object of achieving perfection before one was offered on the market.

The fact that large-grained sands give stronger cores under equal conditions than small-grained sands is not a new discovery.

The writer spent about twelve months continuous laboratory research work prior to 1914, on core making in conjunction with an eminent Doctor of Science in the North of England and another gentleman (at present the Managing Director of one of the biggest engineering concerns in the country, and also a recognised inventive genius), and the above fact was recognised from the beginning.—Yours, etc.,

"QUO VADIS."

December 28.

Sand-Mixing Machine Demonstration.

Pneulec, Limited, of Mafeking Road, Smethwick, near Birmingham, are demonstrating the potentialities of the Pneulec Royer sand-mixing machine at 290, Stockport Road, Ardwick, Manchester, from Monday, January 9, to Saturday, January 21. Two sizes have been installed, and will be demonstrated by Mr. W. Warmington with Mr. B. Lines.

The International Cast-Iron Pipe Ring.—Mr. Edmond Petit, Suffolk House, Laurence Pountney Hill, London, E.C.4, the British representative of the Pont-à-Mousson Foundries, informs us that recent reports are to the effect that French interests are connected with an International Ring of Cast-Iron Pipe Makers, using centrifugal patents. The Pont-à-Mousson Foundries are in no way connected with such a "ring."

Strip Casting.*

By W. A. C. Newman

The operations involved in strip casting are divided into two main groups: (1) Melting and (2) casting. In melting the principal points for consideration are: (*a*) Type of furnace and class of fuel, tilting, stationary or reverberatory, gas, coke, oil or electric; (*b*) size and shape of furnace hole; (*c*) capacity; (*d*) consumption of fuel; and (*e*) utilisation of waste heat.

By far the greatest proportion of the furnaces in this country are coke-fired and of the stationary type. There is, however, a good sprinkling of the tilting variety. The use of gas-firing is extending, and its economy, or otherwise, in relation to coke is one of the most debated questions among foundrymen. Gas furnaces are relatively infrequently used, though they are more cleanly and under better control than coke furnaces. The recovery of spilt metal is easier, and the quantity smaller; crucible life is probably shorter. The quality of gas is maintained at a steadier level than that of coke, and thus regularity of working is ensured. Gas firing is usually noisier owing to the need for compressors, and requires more skilful manipulation to obtain the correct mixture of gas and air for the best heating efficiency. As regards consumption, Mr. Hocking, the late Superintendent at the Mint, gave figures to the Institute of Metals in 1917, comparing gas and coke firing over periods of five years when melting similar types of metals and alloys. They are as restated in Table I.

TABLE I.—*Relative Efficiency of Gas and Coke Fired Furnaces.*

	Melt per furnace, 10 hrs.		Inc. in output.	Pouring Temp.	Cub. ft. of gas per lb.
	Coke.	Gas.			
	Cwt.	Cwt.	Per cent.	Deg.C.	
Gold ..	5.2	9.8	88.5	1,150	3.12
Silver(1/-)	5.7	12.8	124.5	1,090	5.00
Bronze ..	5.2	13.4	157.7	1,165	6.50
Cupro-Nickel	3.6	9.4	161.1	1,300	9.8

Electric Melting.

Electric furnaces for the melting of non-ferrous metals are still in their infancy, but for special purposes, in the case of iron and steel, they have been used widely. It may be said with confidence that the advent of the induction furnace, typified by the Ajax-Wyatt and the Ajax-Northrup furnaces, has opened up the possibilities in this field much more than hitherto. These furnaces are in strong competition even now with the older types, particularly where work is carried on through the 24 hours, and where high purity and freedom from contamination are desired. If power could be obtained more cheaply—down, say, to ¼d. or ½d. per unit—they would undoubtedly come into greater use. The newer, medium-frequency furnaces of the Ajax-Northrup type are particularly impressive, as their capacity is much greater than the earlier ones, which worked at higher frequency. Unfortunately their capital cost is at present rather high.

Capacity.

The most suitable capacity for the furnaces is directly related to the nature and size of the castings to be produced and the magnitude of the output expected. Where large ingots are being cast, the crucible charges may be larger than where the strip bars are narrow and small. In general, the crucible charge should not bear more than a definite, comparatively small relationship to the day's output; otherwise the failure of a furnace for any reason would mean the loss of too large a proportion of the output. In Mint practice we prefer to keep this ratio at about 4 to 5 per cent.

The utilisation of waste heat issuing from the flues and passing up the stack is a problem which has not hitherto had all the attention it deserves. In nearly all furnace installations some use could be made of the escaping heat units. The temperature of flue gases may range between 500 and 1,000 deg. C., and tends to be particularly high in the case of gas and oil furnaces. The following examples are given of the manner in which heat utilisation could be effected:— (1) Preheating the charge; (2) preheating the gas or air in the case of gas-fired furnaces; (3) raising steam direct, and (4) heating feed water for the boiler plant in some kind of economiser.

The economies which may be possible by each of these methods is worthy of consideration. The preheating of gas and/or air will probably be the most attractive. It is quite feasible with atmospheric burners working at low pressures by using a species of regenerative chamber. But with this system the time taken up in heating from cold is so great that 24 hours' working is a necessity, or at least some means of keeping the furnaces hot during the non-working hours. The preheating of either gas or air when under high pressure is more difficult. The speed of travel does not permit of taking up of much heat from the flue gases. In addition the problem of providing suitable heat-resisting pipes to convey the gases to the furnace through any flue chamber has retarded the application of such a method.

Recently the Mint has adopted an extended system of preheating the charge, and the results so far appear to justify the scheme. Average figures indicate that the gas consumption per cwt. has decreased by some 15 to 20 per cent. in the case of each alloy, and there has been a corresponding increase in output.

CASTING.

The factors which enter into the pouring operation may be summarised as follows:—(1) Temperature of melt and of moulds; (2) fluidity or viscosity; (3) rate of flow; (4) dimensions and design of moulds; and (5) condition of mould.

Temperature.

It is a commonly accepted principle that the pouring temperature should be as low as is compatible with getting the whole of the melt out of the crucible, forming solid castings, and allowing any occluded or trapped gases to escape from the mould. A figure usually named is 100 to 150 deg. C. above the freezing point of the material. But this cannot be taken as a hard and fast rule, for it is obvious that the body of the metal to be poured, the size of the mould, the melting point of the metal or alloy, and the solidification range are all points which bear on this important question. The pouring temperature can be lower when the bulk of metal is small and the mould takes the whole of the melt, than when the former is large and the moulds small. Further, it is possible to employ a smaller excess temperature in the case of a large charge than in the case of a small one, when pouring into similar moulds, as the radiation losses are relatively lower. In strip casting the conditions are usually those of a large body of molten metal being poured into comparatively small moulds, and it therefore becomes necessary to use higher pouring temperatures than when, say, large sand castings are to be run. In casting bronze containing 95 per cent. of copper, the pouring temperature for a 350- to 400-lb. melt is normally taken 200 deg C. above the freezing point. The time taken to pour such a charge into moulds ⅜ in. by 3¼ in. in section and 24 in. long is about eight minutes. The drop in temperature is 50 to 70 deg. C. With alloys which have to be made hotter the temperature drop may reach 100 deg. C. This variation of temperature during pouring is liable to lead to irregular working qualities of the bars, but except under unusual conditions it is found with the majority of coinage alloys that a drop of 50 to 80 deg. C. is allowable without seriously impairing the mechanical properties. Two methods are available to reduce this temperature drop in the crucible: (1) By surrounding the crucible in the cradle with an insulating shell in order to reduce radiation losses, and (2) by reducing the size of the charge when pouring into the smallest bars, thus maintaining a fairly uniform total time of pouring.

Bars poured in this manner have clean edges and good surfaces; the pipe extends a fair way into the ingot, showing good contraction and indicating general solidity. Any tendency to overheating results in excessive splashing and, at the moment of casting, the liberation of large quantities of gas with which the melt has been supersaturated. This gas does not all leave the melt; part is entrapped and is the cause of some of the unsoundness. Increase in the rate of pouring accentuates these phenomena, while a decrease usually results in the diminution of the internal defects and a development of external ones. The slower pouring enables the ideal condition of solidification in successive layers to be attained much better than when the rate is greater. On the other hand, if pouring is too slow, the severely chilled metal crystallising from the mould surfaces obstructs the continuous flow of fluid material.

Messrs. Bamford and Ballard have recently come to the conclusion, that in ordinary foundry practice, using coke fires, it is impossible seriously to weaken the mechanical properties of a 70:30 brass casting by overheating or prolonged heating of the melt in the furnace. Cooling to within close range of the freezing point, however, certainly does so, and renders the casting porous. Their experiments also show that if the conditions of pouring are correct the nature of the atmosphere in which the metal is poured does not decrease the soundness of the casting. Thus they obtained solid ingots in each case when air, hydrogen, coal gas or sulphur dioxide was the surrounding medium. These results are rather contrary to the usual experience, and one would welcome confirmation in large scale operation.

Mould Temperatures.

Suitable mould temperatures have not been investigated as closely as pouring temperatures. In general it may be said that the initial temperature of the moulds should not be less than 100 to 150 deg. C. This is very much exceeded where several charges have to be poured into the same moulds. Cooling between melts is not always sufficiently speedy where output is a consideration, and in many instances quenching of the moulds is resorted to. Serious differences of opinion exist as to the advisability of such drastic treatment. Brearley, using large-sized moulds, obtained nearly 100 per cent. increase in life by quenching between heats. In strip casting the better method would appear to be to have such a supply of moulds that they can cool sufficiently by merely opening up to allow free circulation of air round them. Warming of moulds is essential in order to remove moisture from the surface and to temper the severe chilling as the metal enters; but here is a critical point beyond which warming merely exchanges one defect for another. Further it is necessary that the moulds be heated evenly in order to avoid the setting up of undue strains.

A knowledge of the temperature range of solidification is important in order that it may be known not only what is happening in the crucible but what is occurring in the mould itself. The pouring temperature must be, as we have seen, sufficiently above the freezing point to obtain a solid casting, but it is also important to know the possible changes taking place in the constitution and composition of an alloy whilst it is solidifying. Moreover, it is during this pasty stage that liquation effects chiefly occur, and a reshuffling, as it were, of the elementary constituents takes place.

Contraction on Cooling.

The linear contraction of an alloy is a function of chemical composition, of temperature, and nature and size of mould; relatively small amounts of impurities affect it. Theoretically the higher the pouring temperature the greater the contraction, as less metal can be held in a mould cavity at a higher temperature than at a lower temperature. Actually, pouring at an intermediate temperature

* A Paper read before a joint meeting of the London Sections of the Institute of Metals and the Institute of British Foundrymen, Mr. A. H. Mundey presiding. The author is an official at the Mint.

XUM

gives greater contraction, as the evolution of gases at the higher temperatures causes a certain amount of artificial expansion. Generally speaking, the smaller the cross section the less the contraction for a given length; similarly if the cross section is maintained constant the greater the length the less the contraction. Contraction is greater in chill moulds than in sand moulds, assuming other conditions to be the same.

Fluidity.

This property is intimately connected with temperature, the higher the latter the less the viscosity. Adequate fluidity is necessary in order that the metal may fill the mould uniformly and that the chilling metal may unite with the solid material already in the mould. If perfect union does not occur unsound ingots result. It is obvious that there must be a critical value of the viscosity above which pouring should not take place. Japanese investigators have recently stated that in the case of most metals the viscosity attains a maximum value at about 100 deg. C. above the freezing point. This would be in reasonable agreement with general casting temperatures, but confirmation of this apparent regularity must be awaited.

Rate of Pouring.

The rate at which the metal enters the mould will affect the speed of solidification and is related to the pouring temperature. With metal sufficiently hot and flowing in a moderate stream, every opportunity is given to the occluded gases to leave the metal. With colder metal and a similar or slower rate of pouring, premature chilling results, and the ingots are uneven and rough. A primary consideration in the production of sound ingots is that the mould should be filled from the bottom upwards, and that solidification should follow the same general rule, so that each layer of solidifying material is in contact with still molten metal which can feed into the cavities caused by shrinkage, while at the same time offering the minimum of resistance to the liberated gases. In this manner the secondary filling commonly practised with large ingots in order to fill in the pipe is approximately copied. At the same time the bottom of the ingot is assured of being completely filled. A slower rate of pouring as the top of the mould is approached is found to help considerably.

Dimensions and Nature of Moulds.

The functions of the mould are to contain the metal and to conduct away the heat from the casting, so that the latter may solidify in a reasonable period. It must, at the same time be sufficiently strong to withstand normal handling.

Hematite iron is usually used in mould construction, although steel, malleable iron and nickel-chrome alloys have also been employed. The iron should be close-grained and capable of good machining, in order that the moulds may fit closely when placed on carriages. The quality of the iron is too frequently left to the discretion of the iron founder, and, indeed, there appears to be considerable difference of opinion as to a suitable composition. This is shown by the figures of Table II.

TABLE II.—*Composition of Ingot Moulds.*

	Lochner.	Redding.	Anderson.	Johnson.
C.C. ..	—	0.10	0.13	0.84
Graph. C.	—	3.57	2.98	2.76
Si.	up to 2.5	2.10	2.15	2.02
Mn. ..	>1.25	0.51	1.41	0.29
S. ..	>0.1	0.66	0.086	0.07
P. ..		0.23	1.26	0.89

The greatest variations appear in the percentages of combined carbon, phosphorus and manganese. The phosphorus-silicon contents are usually regarded as the principal alternating factors. There is one school which demands high phosphorus in order to obtain good mould castings, while another school believe that the lower melting point of the phosphide eutectic tends to cause premature mould decay and they demand low phosphorus content.

Investigations in the Research Department at Woolwich have shown that smooth ingots of bronze, suitable for rolling, can be obtained from moulds of semi-steel CC, 0.79; Si, 1.43; Mn, 0.96; S, 0.071; P, 0.046. The moulds had a long life.

Prof. Carpenter and his collaborators have shown that growth in cast iron on repeated heating, a phenomenon well known, is directly caused by the oxidation of iron silicide, and is therefore related to the silicon content of the mould material. This growth may on occasions become excessive, say 10 per cent., when the silicon approaches 3.5 per cent. The presence of nitrogen or hydrogen increases the amount of growth, while phosphorus, sulphur and manganese tend to diminish it. An iron containing 3 per cent. C, 0.6 to 0.7 per cent Si, 0.5 per cent. Mn, is said not to grow at all, while one containing 2.5 per cent. C, 1.5 per cent. Mn, 0.5 per cent. Si, 0.1 per cent. S, and 0.1 per cent. P, actually contracts to the extent of 0.5 per cent. The maximum growth usually accurs at a point about ⅓ of the way from the bottom of the ingot, where the heating is at a maximum, and where, incidentally, there is a tendency for the formation of an area of unsoundness.

For good rolling the edges of the ingot mould should be perpendicular to the face. Any chamfering to assist in releasing the bar from the mould induces bad rolling and cracked edges. The majority of alloys contract sufficiently to render such assistance unnecessary. For the production of good surfaces on the bars the faces of the moulds should be machined. This removes the hard casting skin, but the after-treatment of the moulds should provide a protection which compensates for this.

In some cases the newly-machined moulds are allowed to weather for some time and so become covered with rust. This is supposed to confer on the surface some life-prolonging property which is more imaginary than real. A more preferable way is to heat new moulds at such a temperature that they become blue on the surface. In this manner mould stresses are reduced, a hard oxide skin is formed, which is very resistant. Another method which is giving good results is one in use at Woolwich for which the author is indebted to Mr. Nesbit and Mr. Thorne. In this case the surfaces are consolidated by bombardment with small steel shot in a glorified sand-blasting machine. Moulds with aluminised surfaces are also being tried—so far with satisfactory results. New moulds invariably yield poor ingots on the first one or two occasions they are used, but the effect quickly dies down, particularly if they are given a wash of china clay slurry on the surface.

The thickness of the mould walls should not be less than ¾-in., and should increase with, but not in proportion to the size of the ingot. They should be of such a thickness that the heat from the casting is dissipated so quickly that at no time is their temperature nearer than, say 250 deg. C. to the melting point of the metal. Walls too thin warp readily and do not permit the maintenance of uniform temperatures. On the whole it is better to err in having the walls too thick rather than too light. It must also be remembered, in this connection, that casting into a chill mould requires a higher temperature than when casting into sand. Where the back and the lid of the moulds are not of the same thickness contraction cavities tend to be on the side nearer the thinner wall.

The size of the ingot itself is dependent on the nature of the work to be done upon it and the nature of the alloy. Thin ingots imply lower rolling costs, and are therefore preferred in many instances. Their use is a result of the balancing of economies in rolling costs and melting expenses to produce sound ingots. Given satisfactory conditions the thicker ingots yield sounder metal, and in many instances such ingots are afterwards rolled and then slit into appropriate widths. In their casting a rapid rate of flow can be maintained without disturbing the benefits arising from the increased thickness. On the other hand, casting into thin moulds—½-in. thick—demands a higher temperature and a fairly rapid flow in order to allow solidification to proceed normally. One advantage small ingots have is that the grain size is much more uniform, resulting in better mechanical properties.

A frequent occurrence in strop casting is a hollow on one or both broad faces, indicating transverse contraction on solidification. To counter this it would be necessary to go to the expense of giving slightly concave surfaces to the moulds, so that the metal when cast in them ultimately takes up its proper rectangular form. Moulds of this nature would naturally be more expensive.

The life of a mould depends on so many factors that it is impossible to give any reliable average figures. It depends principally on the nature of the mould, the casting temperature, general care in handling, cooling between melts, etc. The life of a grey-iron mould is shortened by too many coolings to ordinary temperature and is considerably lengthened if it is possible to keep it in continuous work, allowing only for normal cooling between melts.

One of the most serious factors which shortens mould life is the cracking which frequently occurs transversely across the back of the mould which is in contact with the front of the ingot. The cracking occurs much more often on this face than on the other, and most of all in the region of the supporting lugs. The first indication is the formation of a fine scaly deposit. This defect has been attributed in part to the impinging of hot metal on to the surfaces of inclined moulds and partly also to residual strains remain-unrelieved since the ingot mould was cast. One cure is to cast vertically into the moulds through a dozzle when there can be no point of concentrated heat. Cracking of the mould in its early stages does not cause the ingots to be so bad that they must be condemned, and it may be made less obvious by painting the mould surface with China clay. The deterioration once begun, however, is very rapid in going to completion, and the remaining life of the mould is comparatively short.

Mould Dressings.

The variety of mould dressings which are used in different works is indicative of the many attempts which have been made to obtain sound ingots with good surfaces. It appears that no general rule can be applied when casting ordinary commercial alloys. Indeed, the function of the dressing itself is involved and uncertain. It would seem reasonable to suppose that there would be some dressing, or dressings, most suitable for each metal, but there is certainly no uniformity in practice, and each foundryman prefers his own pet devices.

The most commonly used dressings are olive oil and lard oil, or mixtures of these, with plumbago; oil and resin; olive oil, turpentine and lard oil; tallow and oil; bone ash and water; thin fireclay; and a mixture of fireclay and sodium silicate applied in layers (this is not suitable for non-ferrous work).

A dressing which promised well was one of soot applied by holding the mould over burning turpentine or an acetylene flame. In the author's experience the results have been disappointing. While the surface was considerably improved the soundness deteriorated, and in addition the problem of applying an acetylene flame to a large number of strip moulds quickly and efficiently in large-scale work is no small one.

The flash point and the cracking point of a dressing should bear a rough relationship to the casting temperature of the metal to come in contact with it. Thus, for high-temperature casting a low flash-point oil, or one which cracks at a low temperature, is not satisfactory, owing, in the first place, to the wastage of oil in burning or by decomposition, when it should remain on the mould, and in the second place to the possible absorption of products of decomposition in the casting.

The part played by a mould dressing in the casting operation may be very complex. It may act as a protection to the mould, and there is no doubt this is largely the case particularly when using inorganic materials such as china clay. These are especially useful in filling in small cracks and other inequalities in the mould surface. Similar action may occur with the ordinary carbonaceous dressings, when the carbon left as a decomposition product acts as a filler. The burning of an organic material affords a reducing atmosphere in which the metal may be cast and

allowed to solidify. This tends to prevent oxidation, but is liable to bring its own troubles in the absorption of the reducing gases themselves. For this reason, if for no other, the amount of lubricant should be limited to the minimum quantity actually required. In addition to acting as a deoxidiser, the reducing gas may possibly act mechanically in attaching itself to included matter or otherwise causing it to rise in the melt during its own passage.

Failure to clean and scrape moulds at definite intervals results in rough castings. In some instances the dressing brushes out cleanly, but in many cases, particularly with high zinc alloys, a day's work leaves the moulds coated with a hard, tenacious skin which is difficult to remove. A sample of such material from moulds used for brass assayed about 70 per cent. zinc oxide. The latter appeared to have formed a cement-like material with the oil. In our own practice at the Mint it has become essential thoroughly to scrape the moulds each morning, and in very bad cases to treat the moulds in hot caustic soda solution.

Unsoundness or Ingot Defects.

Defects in ingots may be divided conveniently into internal and external varieties. The former are mainly blowholes, contraction cavities, and inclusions, which on visual examination of a cross-section are seen to possess fairly definite characteristics:—(1) Clean spherical holes of varying size, with bright surfaces. These have obviously been produced under reducing conditions, and very possibly enclosed some reducing gas. (2) Similar holes with black or dark interiors, due to oxides or sulphides. (3) Elongated cavities, more prevalent in the interior, and usually extended from the pipe. They usually occur with non-oxidised surfaces, as they are normally not produced in the presence of gas, but are due to contraction in the passage from liquid to solid. (4) Irregular masses of dirty material which may have contaminated the surrounding material by interchemical reaction; and (5) a general porosity consisting of very minute holes spread over the whole mass.

External defects may be classified as:—(1) Folds and incomplete castings due to chilling; (2) exposed gas holes, probably derived from the use of too much dressing; (3) flaking; and (4) surface inclusions, picked up from the crucible, charcoal covering or slag, or dissolved oxides.

Gas and contraction cavities roll out, forming hidden flaws. Where they occur there is always the hope that in the fillets or strips the sides have become united under pressure. This, in fact, is rarely the case, and only occurs at all in hot rolling at welding temperature, and if the surfaces are clean and free from oxides, sulphides, etc. Gas bubbles invariably reveal themselves in annealing as blisters or flakes due to expansion, whereas in the case of contraction cavities there is a greater tendency to lie low, there being no contained gas to lift the overlying metal. The possible relationship between blisters and flaking on the rolled fillets is a disputed point. It is fairly evident, however, that, in rolling, the skin covering blisters nearer the surface becomes very attenuated, and might conceivably break, causing flaking.

Unsoundness is not necessarily confined to the top or pipe portion of an ingot. It may be in evidence in two or three regions, particularly at a point some way from the bottom, probably coinciding with the spot at which the initial splashing quietens down and the crystals growing in from the sides obstruct the regular solidification of the metal. Signs of unsoundness may also be fairly commonly found towards the edges of the ingots but a little way in.

A considerable amount of attention has been given to the question of the effects of gases in metals and their removal, but the solubilities of gases in fluid metals is a field not yet covered very extensively. It must be agreed that each of the metals and alloys when molten can dissolve definite quantities of any of the gases, depending on the temperature and pressure, and in casting, therefore, each class of ingot presents its own peculiar problems, which have to be determined and solved, in most cases, purely empirically. For example, the solubility of oxygen in silver is very many times the solubility of the same gas in copper. When the two metals are alloyed the absorption power of the silver is reduced, and a state is eventually reached where we have a balanced reaction between silver and cuprous oxide on the one hand and copper and silver oxide on the other. Another example comes readily to one's mind in the greater solubility of gases in iron and steel than in non-ferrous metals. There is one marked difference, however, between the solubility of gases in molten metals and their solubility in ordinary liquids. In the majority of instances, in the former case, the solubility increases as the temperature rises, whereas in the latter case the solubility falls.

The following general relationships between gases and fluid metal may occur. (1) Total insolubility of the gas in the fluid metal. So long as the metal remains sufficiently liquid the bubbles will ascend and be liberated, but any gases still present in the metal when solidification has commenced, or when the viscosity has risen above a certain critical point, will be trapped. The rising gases may easily act as scavengers in the metal, and by their own buoyancy bring extraneous matter to the surface, thus playing a small but significant part in producing a sound casting. In addition, they reduce the partial pressure of any dissolved gas, causing it to be liberated, too. Mr. Archbutt has definitely used a similar method by purposely introducing a stream of nitrogen into molten aluminium alloys with this particular end in view.

(2) The gas is soluble only in the fluid metal. As the strip ingot cools, such gases are liberated to an increasing degree, and if cooling be sufficiently slow the metal will be completely free when solid. Sudden quenching or chilling results in the retention of the gas in a very dispersed form as tiny bubbles. Under normal casting conditions some of the gas would be given off, but undoubtedly some would be retained in the ordinary spherical cavities formed by the coalescence of the smaller bubbles.

(3) Gas partially soluble in the molten metal and also in the solid. Under these conditions the gas absorbed by a molten metal may be split into three portions:—(*a*) Part released in cooling; (*b*) part entrapped in the solidifying metal; and (*c*) part dissolved in the solid. The influence of these portions may be very diverse. That of released gases as a scavenger we have already noted. Entrapped gases form the blowholes whose evil effect is well known. Dissolved gases may have an effect which is not quite so clear. It is possible that, according to their solubility and their own particular properties they may confer varying mechanical and chemical properties on the metal or alloy which contains them.

(4) The gas combines chemically with the metal. This may result in the solution of the compound formed, *e.g.*, CuO in copper, its expulsion in the slag or its retention as an unwanted inclusion.

Air absorbed from the atmosphere or entangled in the stream and the furnace gases are the principal sources of the gases found in castings, and they may yield oxidising reducing and neutral gases. The principal oxidising agent in this connection is oxygen itself, though carbon dioxide may on occasions act in this manner. The reducing gases are hydrogen and the saturated and unsaturated hydrocarbons, with possibly sulphur dioxide, while nitrogen, carbon dioxide, and sulphur dioxide are normally neutral. Of these, oxygen is the most chemically active in contact with metals, and the oxides thus formed, if not removed, are dissolved, or appear as inclusions. In certain instances the other gases react, as in the case of nitrogen in iron and magnesium when nitrides are formed.

There is some evidence that in many cases other gases are more soluble in metals than oxygen. Prof. Carpenter and Miss Elam have published results for gunmetal. They found that the gases do not readily escape from the metal, and observed the spurting of beads on cooling (Table III).

No marked difference, however, between the gases was noticed which would account for the absence or presence of blowholes—a fact which conforms with other observations that apparently quite sound ingots contain considerable quantities of absorbed gas, most probably a highly dispersed phase. Dr. Hatfield has pointed out, for example, that the gases from a piece of blown steel are less in volume than, but similar in composition to, those from a sample of sound material, and incidentally suggests that use might be made of this fact by adding to steel certain proportions

TABLE III.—*Composition of Gases in Gun Metal.*

	Pump started simultaneously with heating.	Apparatus allowed to cool before evacuation.	89 Per cent. Cu. 11 Per cent. Su.	Rio Tinto	B.S. Copper
				Gas collected quickly.	Gas collected slowly.
SO_2 ..	15.6	—	53.4	70.9	61.2
CO_2 ..	3.4	5.8	5.1	19.6	34.9
CO ..	57.6	41.3	27.4	4.7	—
H_2 ..	7.6	41.0	—	—	—
Satd. hydrocarbs.	2.9	1.9	1.4	0.8	—
Unsat. hydrocarbs.	2.4	0.9	1.7	—	—
O_2 ..	1.1	1.2	1.4	1.2	1.1
N_2 ..	9.4	7.8	10.5	2.8	2.8
Vol. of gas 100 grms.	2.17	3.65	1.44	4.45	5.95

of various elements which would increase the holding power of steel for gases, and so possibly confer considerable improvement.

Guillemin and Delachanal have found that in sound brass castings 90 per cent. of the occluded gas is hydrogen, which had apparently no deleterious effect on the mechanical properties, and that chill cast bars contain less gas than bars cast in sand. The gas in this case was probably in a state of supersaturated solution. In the presence of P its solubility is reduced. In unsound castings the gases contained a considerable proportion of CO_2 and CO. Hathersall and Rhead have confirmed these facts. They have shown that molten copper treated with hydrogen will cast soundly under suitable conditions, while copper not so treated, but simply held under charcoal, does not, under the same conditions, give good castings. Lobley and Japson, on the other hand, had found that H_2 is absorbed in Cu at all temperatures up to 2,200 deg. C., and is ejected on solidification, forming blowholes.

The causes for the presence of oxygen, as such, or as oxides in alloys are, principally, prolonged heating, melting without a cover, exposure to an oxidising flame, the introduction of too much scrap which, with its greatly developed surface, offers greater opportunities for oxidation, and in the case of alloys containing copper, the dissolved cuprous oxide. It is common practice to deoxidise a metal by adding a reducing medium, which will combine with the oxygen and pass off as vapour, into the slag or into harmless solution in the metal. To de-reduce a metal an oxidising agent must be added. Whereas, however, in the former instance the products of deoxidation are rendered innocuous, in the latter we are invariably left still with a gas and all its attendant evils, necessitating still careful measures to prevent its retention in a harmful state in the metal. Thus hydrogen will form steam and carbon monoxide carbon dioxide.

The oxygen in copper is present as cuprous oxide, which on solidification of the metal becomes concentrated in the part solidifying last and finally forms a eutectic, which surrounds the crystals as a brittle membrane. Thus 0.5 per cent. of O_2 as Cu_2O does not affect the ductility of copper, but 0.10 per cent. reduces it. In bronze brittleness due to oxygen is less to be feared than in copper owing to the influence of the zinc which reduces the CuO to Cu and forms ZnO—a less harmful constituent.

To a certain very limited extent, oxygen may be beneficial in such materials as the copper alloys by oxidising the impurities which are less harmful as oxides than as the pure elements, and thus assisting their removal.

Non-ferrous alloys may be divided into two classes for deoxidation purposes. (1) Alloys which undergo autodeoxidation when molten, *e.g.*, Al, Si and Mn bronzes; and (2) alloys in which it is difficult to separate the oxide of one or other of constituents. Add deoxidiser (1) to prevent undue loss of reactive constituent and (2) to reduce oxides formed during melting.

The usual deoxidisers are well known, and need not be recapitulated. Their efficacy is in relation to their several heats of oxidation, or, in other words, the heats of formation of their oxides. The higher this quantity, indicating greater affinity for oxygen, the more virile is the deoxidising power of the element. Generally speaking each deoxidiser will act as such to the oxides of the metals below it in the series, which is a useful guide when determining the particular reagent to be used.

The efficacy of an ordinary graphite stirring rod as a deoxidising medium is not fully realised.

The addition of deoxidisers while reducing the amount of included oxides at the same time increases the fluidity which enhances the chances of obtaining a sounder casting.

Inclusions.

Inclusions in strip ingots may be equally as detrimental as gases and blowholes. Charcoal, chips from the crucible, oxides and dross, slag and carbon from the cracking of an unsatisfactory mould dressing may all appear in the ingot. Both subcutaneous and deep-seated foreign matter reduces the strength, and the former may develop into flakes on rolling. Evidences of inclusions are frequently seen in the laminations in rolled strip due to the non-adherence of adjacent metal. These laminations can usually be lifted with any sharp point, and in rolling or spinning are very deleterious.

The various common oxides which may occur as inclusion are those of copper, aluminium, zinc, magnesium and tin. Cuprous oxide dissolves to a considerable extent in copper, but in alloys the conditions are different. For instance, in brass, since zinc reduces cuprous oxide, but copper does not reduce zinc oxide, the latter must be the principal inclusion, if any. Alumina forms a continuous film on the surface of the molten material even when aluminium is present in only small quantities. The oxide is difficult to eliminate. The skin formed on the surface, however, prevents the oxidation of the other oxidisable metals present. The ease with which alumina is formed is the primary cause of the difficulties in casting aluminium bronze and similar alloys by preventing the agglomeration of the molten globules.

Zinc and magnesium oxides are friable and easily become entangled in the melt. Tin oxide forms hard and brittle, well developed crystals, and imparts these properties to the alloys.

Manganese, silicon and phosphorus form oxides which volatilise or pass into the slag.

The external defects are more difficult to classify than the internal ones, for their differences are not so marked. Folds or spills are due to incomplete union of splashes with the main body of metal during pouring, owing to excessive chilling or the intervention of some foreign matter. Pits, which may be circular or elongated, are due principally to mould defects or to inclusions which have attempted to rise up the mould side but have been trapped.

Of the two forms of defects, internal and external, the effect of the latter can be more easily removed, simply by planing the surface. From this point of view, therefore, it is preferable to aim at greater internal soundness than perfection of surface, though from an economic point of view the better the surface the less costly are the subsequent operations. With small strip ingots, such as are used in coinage work and are produced in large numbers, planing is impracticable, and reliance must be placed on the efficiency of casting methods. For superfine work planing is eminently desirable. It becomes then a question of weighing the economic considerations—the cost of additional operations, such as planing—and the purchase of comparatively costly plant which is necessary to ensure the best conditions for ingot production at the outset, against the cost of rejected work due to the defects which have been enumerated.

Irregularities of Composition.

In addition to what may be called the casting defects of an alloy there are frequently irregularities in composition, which may be modified or improved by alterations in the casting conditions. Some, however, remain in the ingot.

Improper mixing, whereby uneven distribution of the constituents may result. This is particularly noticeable where there is an insoluble constituent (*e.g.*, lead in bronze), or where there is a marked difference in density between the original components, or between the phases which may be produced. An instance of the latter is the concentration in the upper layers of an ingot of white metal of the cubes of the tin-antimony compound. Intensive chilling causes better distribution, as the solidification is so rapid that no separation has chance to occur.

Segregation and Liquidation.

The segregation of impurities in the pipe and the central unsound portions of ingots, particularly steel ingots, has long been known, and it has recently been observed that blowholes are often centres of excessive segregation. The differences occurring between the inner and outer portions of gold and silver bullion and of ferrous and non-ferrous alloys in general have also been repeatedly recorded. These differences vary from those which might be expected from a consideration of the equilibrium diagram, and the term inverse segregation has come into use to describe such phenomena. Prof. Benedicks has investigated the carbon distribution in steel ingots, and Dr. Smith and others have similarly explored the vagaries of non-ferrous materials, notably the precious metal alloys. These properties appear to be inherent in each type of alloy, and have to be borne in mind in connection with the particular uses to which the strips are to be put.

A Cast-Iron Shoot.

By "SPRIG."

The making of a casting such as is described in this article is not a job that presents any great difficulties; in fact, for shops using the spindle frequently it is fairly straightforward. It is, however, proposed to show that its production brings out several interesting points, which require foresight, yet, at the same time, make a jobbing shop more interesting than repetition work. To those foundries where the spindle is not so often in use the article should be somewhat instructive. This casting was ordered along with several more, for use in connection with coal-bunker construction, and formed the shoot of the bunker. The casting *per se*, of course, would not

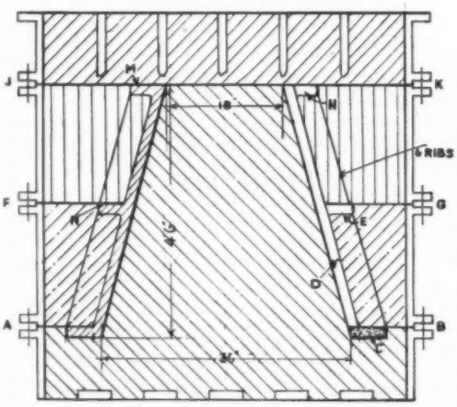

FIG. 1.—A SHOOT CASTING.

be classed as high-grade work. A suitable box was selected, the bottom part of which had strong bars. This factor is one which in all spindle work must have special attention, as it requires to be moved by the crane to the drying ovens, and the spindle socket must therefore be rigid and free from any risk of shifting. The bottom was built up with bricks and loam, and the cone portion struck up in the usual way. The first joint was made on the line A B, Fig. 1. It will be noticed the bottom flange was simultaneously swept up with the same sweeping board. This part was then taken to the stove and dried. When dry, the box was returned to the floor, and work continued by filling up the space forming the bottom flange firmly with black sand, as marked C. A layer of loam was swept up on the outside of the cone, representing the pattern thickness as shown D. The layer was taken right up to the top, as shown on the right-hand side. The bottom box was again taken to the drying stoves, to dry this pattern thickness. It was, of course, necessary to paint on a parting coat between the cone core and the pattern thickness. On returning to the shop floor the first middle-part was next placed on, and the loose wood strips forming the vertical ribbing were placed on, up to the joint marked E, being the under side of the centre puddle flange. This part was then rammed up with sand, using the facing sand mixed with oil to ameliorate drying conditions. The joint F G was next swept. It is necessary to sweep this joint from the spindle to ensure it being 90 deg. to the vertical, and also, of course, of the correct height. This joint was next prepared with parting sand, and the second middle part placed on. The loose wood strips forming the upper vertical ribbing were then fixed, from the joint F G to the point H. This part was then rammed up exactly as the first middle part, and the top joint J K swept, as in the case of the joint F G, except that this joint sweeping-board was so made that the top flange M was formed at the same time. This part was next lifted off, and the loose vertical ribbing withdrawn, and the part finished off. The next job was to sweep out the centre horizontal puddle flange N. This, too, was done with the spindle. The first middle part was then taken off and the loose ribbing withdrawn, and the part finished off. These two parts were then dried by open grid fires, though if shop conditions are suited they could be beneficially taken into drying stoves. The thickness of loam D may now be stripped off, and the sand filling taken out of space C. The top part (or cope) was rammed up on a surface plate. The runners were taken down to the bottom flange, at opposite corners of the box. There were step runners taken off to the centre flange, for the purpose of livening the metal as it arrived at this point, by breaking up any scum head that may be formed. It was necessary to place many lifters, or gaggers, and soldiers, to carry the overhanging sand. Needless to say, owing to it being a dried mould, the casting had a good surface, and was also true to shape.

Contracts Open.

Cairo, January 16.—(III) Supply, erection, maintenance, etc., of two sets of 4-in. duplicate centrifugal pumps driven by electric motors, for the Main Drainage Department, Ministry of Public Works for the Egyptian Government. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,691.)

Cape Town, January 18.—Disconnecting boxes, for the City of Cape Town Electricity Department. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. B.X. 4,088.)

London, S.E.1, January 13.—Eleven turntables for 5 ft. 6 in. gauge wagons, for the India Store Department, Branch No. 14, Belvedere Road, Lambeth. (Fee 5s. per set, non-returnable.)

London, S.W.1, January 10.—Metals (comprising aluminium, antimony, brass rods, sheets and wire, copper ingots, rods, sheets, tubing, wire, phosphor copper, lead piping, sheeting and zinc sheets, etc.), for the Madras and Southern Mahratta Railway Company, Limited, 25, Buckingham Palace Road, Westminster, S.W.1. (Fee £1 1s., non-returnable.)

Southend-on-Sea, January 31.—Three pump sets, each set consisting of a centrifugal pump capable of pumping 870 gallons of screened sewage per minute against a static head of 59 feet and driven by an internal-combustion engine of appropriate size, for the Town Council. Messrs. Dodd & Watson, the engineers, County Chambers, Corporation Street, Birmingham. (Fee £2, returnable.)

Wakefield, January 21.—Cast-iron gully grates and frames, etc., during 12 months ending March 31, 1929, for the West Riding County Council. The West Riding Surveyor, County Hall, Wakefield.

Some Methods of Production in a Modern Malleable Iron Foundry.*

By A. J. Beck.

It is not proposed to deal with the metallurgical side of this subject, that being in the hands of an efficient laboratory staff, which controls the analysis, and gives the foundry suitable metal at high temperature from ten air furnaces. Six of these are hand-fired with 5- or 6-ton charges, and the remaining four by pulverised fuel, two take 10 to 15 tons per charge, and two others 15 to 20 tons per charge. It is proposed, however, to detail the methods of moulding that have enabled the Leys Company to produce over 10,000 tons of malleable castings during the last 12 months.

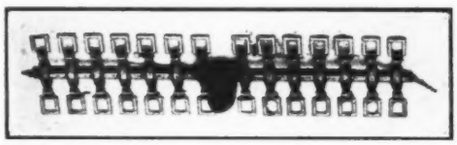

FIG. 1.—ONE-THIRD BOX: 0.025 LB. PER CASTING.

All the samples illustrated are machine moulded, and are fairly representative of about 75 per cent. of the total output.

Types of Machines Used.

Most of these are made at the plant, with the exception of the sandslingers. The oldest type is a hand-squeeze (Farwell). This has a simple saddle top with hand lever and balance weight, and is used for very light work with intricate joints, or short-order work which would be too expensive to mount on pattern plates. For this machine, runners and feeders are attached to patterns which are made in brass, and the moulds are made in snap flasks from an oddside which may be made from ground red sand, doped with waterglass or silicate of soda, gutta-percha, plaster of Paris, or val-de-travers.

Air squeeze machines, of which there are over 100 in use, are fitted with a cylinder having a bore of 8 in. and a stroke of 6 in., with a lift of approximately 5,000 lbs. One squeeze is generally sufficient for one mould. They are fitted with air vibrators to assist in drawing patterns, and with a blow-valve for cleaning. They work at 100-lb. pressure.

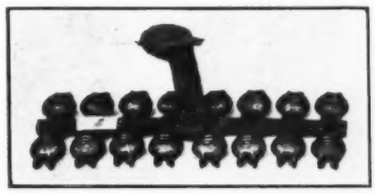

FIG. 2.—ONE-THIRD BOX: 0.033 PER CASTING.

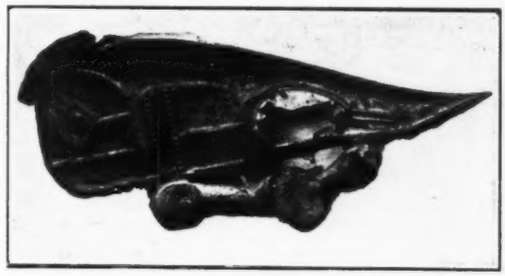

FIG. 4.—FULL BOX: 10 LB. PER CASTING.

FIG. 3.—ONE-HALF BOX: 2.5 LB. PER CASTING.

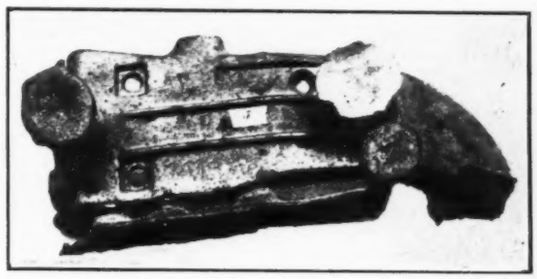

FIG. 5.—FULL BOX: 20 LB. PER CASTING.

Squeeze jolt machines, of which there are 18 in use, are a combination of squeeze and jolting operations. This method is very useful when deep drags and shallow copes are used, and castings of unequal contour may be made without the use of shaped follow boards.

Jolt ram.—These machines are invariably used in pairs for twin plates, and have a 4½-in. bored cylinder, with a 2¼-in. stroke. Four to six jolts are generally sufficient for each mould. These, too, are fitted with air vibrators and blow valves, whilst the lifting capacity is approximately 1,500 lb. The moulds are turned over on the pattern boards or plates, the usual turn-over operation by the machine being too slow, and a source of trouble by wear from sand on the machine slides.

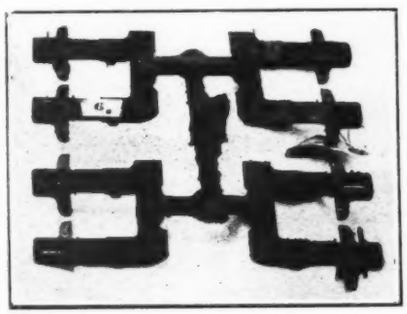

FIG. 6.—FULL BOX: .5 LB. PER CASTING.

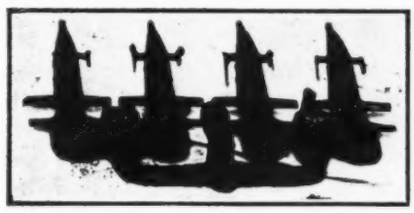

FIG. 8.—TWO-THIRDS BOX: 1 LB. PER CASTING.

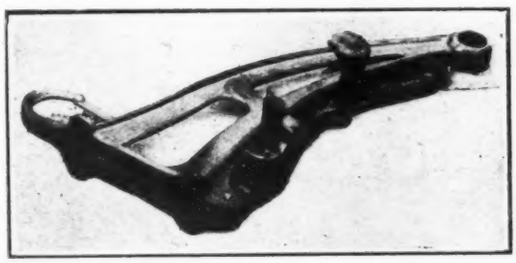

FIG. 7.—ONE-HALF BOX: 6 LB. PER CASTING.

FIG. 9.—ONE-HALF BOX: 4 LB. PER CASTING.

Sandslingers.

These machines are driven by electricity and travel into the sand pile under their own power, collecting the sand from the floor by means of a left and right-hand cutting screw conveyor, which conveys the sand to the centre of the machine, where it is lifted by means of a bucket elevator, and deposited on the screen of an oscillating riddle. The sieve is arranged and constructed so that scrap, core, etc., which may be in the sand, work down into the chute, and from thence into the scrap box, which is mounted on the main arm. The riddled sand is conveyed by the oscillating sieve into a hopper mounted on the impellor arm above a belt that conveys the sand into the impelling head, which discharges the sand with centrifugal force into the moulding box. The ramming capacity can be regulated by the speed it is fed into the sand pile. The impelling head has a 9-ft. radius, right and left-hand cutting screw conveyor is 11 ft. wide, the machine operates in a bay of at least 15 ft. wide and 200 ft. long. The moulding boxes used have bars cast-in, in the form of a grid, 2 in. deep. They are not flat, but are suitably spaced so as not to foul the runners and feeders.

It is now proposed to describe the samples illustrated in Figs. 1-19, and will now treat each one, mentioning type of machine on which they were made, whether made in snap flasks or iron moulding boxes, material patterns are made of, methods of feeding and running, knocking off, etc.

Fig. 1 represents one of the smallest castings made that requires a core. There are 84 of each in one mould, a snap flask, 15-in. × 12-in., having

* A Paper read before the East Midland Branch of the Institute of British Foundrymen, Mr. Pemberton presiding. The author is on the staff of Messrs. Leys Malleable Castings Company of Derby.

a cope 4 in. deep, and the drag 3 in. deep. Each core must be placed in position separately and the fitting of this link must not vary beyond $\frac{1}{64}$-in., or it is rejected. This sample, illustrated in Fig. 1, has not been cleaned in any way whatever, and is just as it came out of the mould, it is $\frac{1}{4}$ of a complete mould. The patterns are made of brass, and soldered to a brass runner bar. Three sprays of patterns are then bedded into the drag-half of a mould, and then gutta-percha is bedded on, thus forming the oddside, and the job is ready for work on the hand-squeeze machine.

The casting shown in Fig. 2 is produced in the same way, but has no core. It has an irregular joint line, and two fine projections inside the lip, which must be smooth and good. There are three sprays in a box.

Fig. 3 represents a heavier type of casting, normally made on the Farwell machine in a 15-in. × 12-in. snap flask, with two sprays in a box. There is one dry-sand core per casting. Other slots leave their own core without sprigs or nails, which demands neat tucking and ramming. The patterns are of cast iron made in a plaster oddside.

Fig. 4 is a type of agricultural work made on a hand-rammed stripping machine in iron boxes of 20 in. × 12 in. × 4 in. Twin machines are used, making cope and drag simultaneously. Iron patterns stripped through a cast white-metal plate are used owing to the irregular contour of the joint. Fins are placed on various parts of this casting to prevent hot cracks or pulls. There is only one dry-sand core carried in this casting.

Another type of agricultural work of similar design to Fig. 4 is shown in Fig. 5. It is mounted on a cast white metal plate, and is made in a snap flask measuring 24 in. × 11 in. × 8 in. deep. Wrought iron binders are used in each half mould. The feeders, one of which is closed to prevent wasting metal, are removed whilst still hot to prevent cracking.

The air squeeze machine, which was first installed about 18 years ago, is used for snap flasks, ranging from 15 in. × 12 in. to 24 in. × 12 in. up to 12 in. deep. The patterns may be made of wood, brass or aluminium on either $\frac{1}{4}$-in. steel plates, $\frac{3}{8}$-in. aluminium, or 1-in. hard wood boards. The patterns are registered on each side of the

FIG. 10.—FULL BOX: 1.75 LB. PER CASTING.

FIG. 11.—ONE-HALF BOX: 2.5 LB. PER CASTING.

FIG. 13 (ABOVE).—FULL BOX: 2.5 LB. PER CASTING.
FIG. 12 (BELOW).—FULL BOX: 7 LB. PER CASTING.

FIG. 15.—FULL BOX: 9 LB. PER CASTING.

FIG. 15A.—FEEDERS, FOR THE CASTING SHOWN IN FIG. 15.

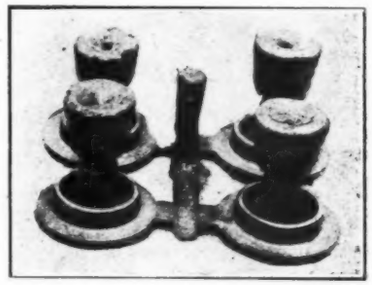

FIG. 14.—FULL BOX: 3 LB. PER CASTING.

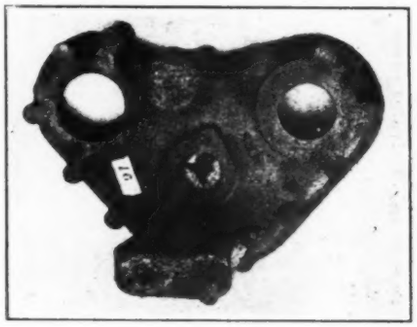

FIG. 16.—FULL BOX: 12 LB. PER CASTING.

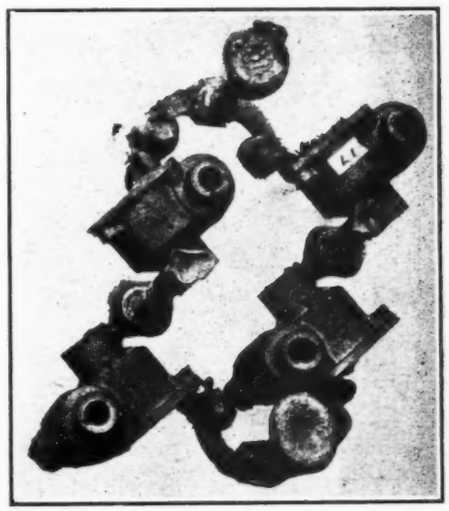

FIG. 17.—FULL BOX: 7 LB. PER CASTING.

plate or board. Perforated malleable iron bottom plates are used in connection with all the air squeeze machines, as the cope and drag are pressed at one operation. All pattern plates are fitted with compressed air vibrators of different sizes, so that it is seldom necessary to rap them. Two interchangeable flasks are used, one being rammed up whilst the other is being cored and closed. Castings made on these machines vary in weight from 2 lbs. to 20 lbs. per box.

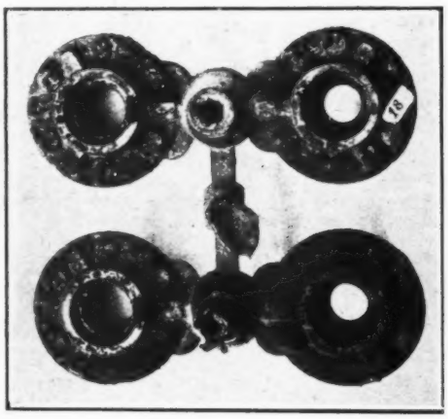

FIG. 18.—FULL BOX: 7 LB. PER CASTING.

A light casting for the motor industry with an irregular joint line is shown in Fig. 6. There are eight brass patterns in a box made from hard-wood board, and there is one core per casting.

A larger casting is illustrated in Fig. 7, but it is still on the light side. The extra piece cast on to prevent the end of scroll jarring off when runners are removed cold is worthy of note. This casting is made from a cast aluminium-plate. There are two castings per box.

A type of agricultural castings of which the Leys concern makes about 100,000 castings per year is shown in Fig. 8. Probably there has been about this quantity made from this particular pattern plate. There are six patterns on a cast aluminium plate, and it carries one core per casting.

Another type of chain link used very extensively is shown in Fig. 9. This pattern is seldom out of production, a man and boy making approximately 1 ton per week. There are two cores per casting and two castings per snap flask. An aluminium pattern on hard-wood board is used.

Fig. 10 shows adjusting nut for motor trade. For its making aluminium patterns mounted on steel plate are used. Two cores are carried per casting, and there are six castings per box. The joint line of this mould is away from the teeth to facilitate moulding and feeding, and a ring core is used to form the top part of this casting, thus making it with no lift at all in the cope.

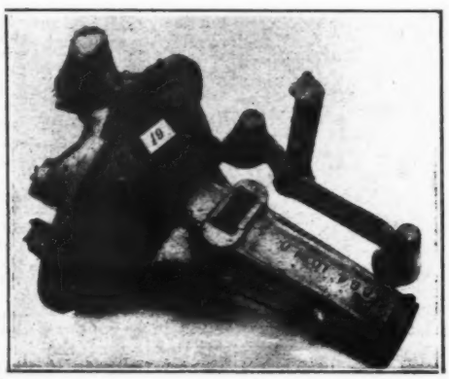

FIG. 19.—ONE-HALF BOX: 27.5 LB. PER CASTING.

Fig. 11 shows a pipe clamp which is air-machine moulded without the use of any dry sand cores, sprigs or nails being used from a cast aluminium plate. There are four castings per box.

Fig. 12 shows a hub for motor industry. In each box there are two castings and five cores. This is an example of the trouble taken to ascertain the correct amount of feeder required for each casting. The feeder is formed by two cores, both made from the same core box and placed together in the mould before ramming up. For its manufacture two aluminium patterns are mounted on steel plates.

Fig. 13 is an illustration of a clip showing an ideal type of top feeder for this class of work, being only about ¼ in. from the body of the feeder to the casting. It has to be removed whilst hot. There are two cores per casting. Four aluminium patterns mounted on a steel plate are used for its moulding.

Fig. 14 is the final example of snap-flask work, and the only one shown that has been chilled. This casting has to be cast stem upwards on account of there being no room for feeder on the reverse side. The top of the casting being the smaller will cool the quicker and leave a cavity at the root of the stem, therefore a specially-made chill is placed underneath the feeder. It will then knock off cold without fear of cracking casting. Four castings per box aluminium patterns on hard-wood board.

Fig. 18 shows a much plainer job containing one core per casting. This core, by the way, is made on a core-blowing machine similar to the one Mr. Russell described when dealing with his visit to America. The size of the box part used 17 in. × 17 in. × 4 in. The method of feeding is one to which resort is often made, that of carrying the metal from the feeder at the side through a pad into the neck of the hub. Three men and four boys will make, core, cast, and shake out seven to eight tons per week off this job. This is made on a drop-plate machine, wherewith the pattern and pattern plate drop and leave mould suspended on out-triggers.

Fig. 19 represents the type of casting suitable for the sandslinger. It weighs 27 lbs., and there are two castings per box, carrying 10 cores, including two gummed in the cope. For its making four complete grey-iron patterns are mounted on twin stripping machines, that is, two copes and two drags. The whole is mounted on a skid, towed behind the sandslinger. To staff this machine efficiently requires 15 men and five boys. A fair day's output from it ranges from 225 to 250 complete moulds, or 450 to 500 castings—in fact it has made 270 complete moulds in 8½ hours. There are actually seven men and five boys producing these moulds, the remaining eight men clamp, cast, shake out, prepare all sand and remove runners.

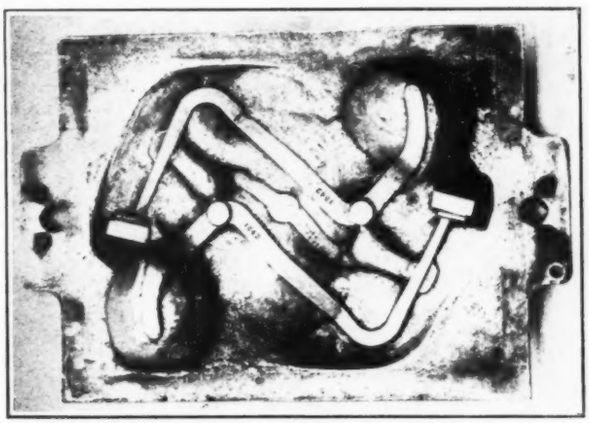

FIG. 20.—CAST ALUMINIUM PLATE.

Squeeze Jolting Jobs.

Fig. 15 is made from a wood pattern mounted on a steel plate in a steel moulding box on jolt-ram squeeze machine. There is one casting in a box carrying two cores. It shows the steps necessary for preventing some of the more fragile castings from cracking during cooling. As shown, two holes are inserted in the core for holding the two heavier sections together. These are removed after annealing; additionally, a fin is placed outside the two bosses for the same purpose, but these are removed before annealing.

Fig. 16 shows a casting made on an ordinary jar-ram machine which after a little trouble was made perfectly sound without any feeder at all, but the use of any other type or runner anywhere resulted in an unsound casting. Even if this type were moved from the thin section the casting would be unsound.

Sandslinger Castings.

These machines are the latest type the Leys Company have installed. They have five actually in work, making from 50 to 60 tons weekly. Fig. 17 shows a small steering box weighing about 7 lbs. For its moulding four brass patterns are mounted on twin stripping machines. There are eighteen dry-sand cores per box, including four gummed in the cope. The size of the box used is 21 in. × 13 in. × 6 in. Four men and four boys make from six to eight tons per week. All cores for this class of work are machine made in oil-sand; in fact 75 per cent. of the cores used are of oil-sand. Note should be made of the fin on two castings to prevent pulls.

The actual output of castings from the foundry floor at the time of writing is:—Castings, cast, 2,000; moulds made, 1,000.

General.

All moulding boxes for machine work whether of cast iron or light steel are used without fixed pins, but are fitted with double lugs all drilled to templates with different centres for various sizes of boxes, but all with a standard size of hole. The steel boxes have no handles, the lugs being used for that purpose. Cast-iron boxes have a lug cast on the corners carrying a hole, into which a bar is placed for handling. This facilitates passing up and down the rows for casting purposes. All pattern-plates for iron or steel boxes are fitted with standard pins and moulds are assembled with a pair of pins placed in the cope. One of the advantages of this method is that each pin goes through four holes, thus eliminating the risk of cross-jointed castings.

Seventy-five per cent. of the castings are poured through dry-sand cores in the form of strainers of different types. This is a great advantage where clean castings are essential.

OWING TO THE rapidly increasing use which is being made of the facilities provided by the Government under the export credits guarantee scheme for the assistance of those engaged in the export trade, it has been found necessary for the Export Credits Guarantee Department to secure larger and more suitable accommodation. The future address of the Department will be 9, Clement's Lane, Lombard Street, London, E.C.4.

Is the Foundry Approaching the Engineer's Standard?

By M. E. Nicholls.

Iron castings are still regarded with disfavour by the engineering machinist, but it is possible that in many cases this is due to inherent prejudice rather than to legitimate reason. Often one will hear the machinist remark, "I don't like working cast iron," but he perforce has to do so, and he generally succeeds in turning out a good job, and with a low percentage of scrap.

It may be that this is a triumph of mind over matter; that, as iron castings have to be used, it is for the machinist to do all in his power to remedy the delinquencies of the foundryman, and make as good a job as possible. He grumbles enough during the process, declaring that the castings are "as hard as flint," or they are "out of alignment," or they "appear to be porous," but as none of these defects are apparent in the finished job, it shows how high is the state of proficiency attained by the machinist—unless it is that some small credit is due to the foundrymen, for producing castings which are not quite so bad as the machinist would have us believe.

And if this is the case, cannot it be said that the foundry is at last approaching the engineer's standard? The machinist continues to grumble, true enough, but he is turning out a good job and, what is more to the point, he is doing the work well inside the schedule time, thereby earning bonus. It is possible, of course, that the schedule time takes into consideration the peculiarities of castings, and that, given the perfect casting, it could be considerably reduced, but as progress is evolutionary we have to get to perfection by easy stages, and in the circumstances there is some reason for pride and satisfaction if some of these stages have been passed.

A most difficult stage has been passed when bickering between the buyer and the seller ceases, for this shows that the seller is determined to do all in his power to satisfy his customer, while the latter is appreciative of the efforts which are being made to satisfy him. The engineer is the foundryman's best customer, and it is of no use for the foundryman to say, "He wants too much." He knows what he does want, and won't be happy till he gets it, so why not let him have it, instead of causing trouble by insisting that it is not good for him to have his own way?

"He wants good castings at low prices," but there is nothing wrong in that. Everybody wants good value, and everybody (including the engineer) will pay the price for quality, but the elusive qualities of castings make the purchase of these as speculative as a "bran-tub dip"—you might get something good, but the chances are that you won't. The perfect casting is not yet evolved; it is, in fact, difficult to get uniformity from one cast, and it is well-nigh impossible to obtain it from two or three different casts. Just as the ideal is about to emerge, something in the nature of a "throw-back" occurs, and although in the abstract elusiveness is said to possess charm, there is little charm for the engineer in the elusive qualities of castings.

The trouble with castings is not so much that they are bad castings, but that they are unsuitable castings, that is, for the purpose to which they are to be put. The engineer is so versatile that he wants a casting for every purpose, and the average foundry cannot keep up with him. The casting may be quite right for one purpose, yet wholly unsuitable for another, and as the foundry must have a definite standard, it is almost impossible for it to cater for all the intricacies of engineering progress. The only thing is for each foundry to find its own place in the scheme of engineering requirements, and develop its resources with a view to satisfying those requirements which come within its sphere.

No foundry consistently sends out bad castings—they are merely sent to the wrong place. By some measurements they are extremely good castings, and would be accepted with something approaching rapture by some folk, but to us, who have received them, they are remarkably bad. Some foundries can be educated up to the engineer's standard; they show promise, but lack technique, which can be acquired by education and perseverance, but some foundrymen do not like this at all. "They know their job, so why should they be taught to do it differently," but as they produce to sell, and can only sell where they give satisfaction, the inference is obvious.

Mixing Consignments for Machining Purposes.

Some foundries, on the other hand, are very persistent. Said one foundry manager to an engineer's buyer, "I am out to get a good share of your business." "Good, go ahead," responded the other, and he did. His first effort showed promise, and so did the second, and then he produced castings which were acceptable. They were not nearly so good as similar castings being obtained from another foundry, but as this foundry could not produce in sufficient volume to satisfy the requirement, a new source of supply had to be found. When castings from the new foundry began to arrive, the machinists clamoured for higher rates, because of the extra work involved, but this was not permissible, and so the products of the two foundries were inter-mixed. A machinist said to the buyer, "The foundry is not sending such good castings as formerly. Some of them are very bad," which was not fair to the foundry supplying the good castings. Some time later he proffered the information that the castings were once again up to standard, and later still he thought that they were better than they had ever been. At this time the bulk of the castings was being supplied by the new foundry, so it was apparent that this foundry had been educated up to the engineer's standard.

There is no doubt that many castings are accepted because they are urgently wanted. Sometimes, as in the instance recorded above, the requirements of the engineer are expanding so rapidly that the recognised sources of supply are inadequate, and he has to take what he can get from elsewhere. In some factories there always seems to be a casting "wanted at a pinch," and the order goes to the "accommodating" foundry, which can be relied upon to effect a speedy delivery. The quality of the casting is scarcely considered, until it gets into the machinist's hands, and then there is an outcry which, however, is suppressed by the statement that "it is the best that we can get at short notice, and the job is desperately urgent." Then there is the disgruntled engineer, who is always looking for new sources of supply, yet never finds one to give him satisfaction. He holds his orders back until the last possible moment, while he looks out other likely foundries, but in the end he is forced to give the order to his old foundry, and then immediately begins to press for delivery, accepting anything so as to avoid delay in his shops.

This is probably why it is that the machinist continues to grouse; he keeps getting hold of castings which have come to the wrong place. He is not enthusiastic even when he strikes a good patch, because "he knows there will be some duds coming along presently," and so the grouse against iron castings goes on. The machinist who is continually working castings declares he has got the rottenest job in the shop. "They are dirty." "You have to be so careful with 'em." "You never know what is going to happen," and yet, in spite of these drawbacks, he is earning good money (comparatively), and making very little scrap.

Perhaps in years to come the machinist will revise his opinions, and even go so far as to say "there is nothing like cast iron." At present this is but a pious hope, but the possibility exists, and it can be brought to reality by co-operation between the engineer and the foundryman. The former must not be blamed for fixing a high standard—this is desirable and even necessary in the interests of industry, and the foundryman must reach this standard. But he must know what standard it is he is aiming for, so as not to send his castings to the wrong place, and here he requires the assistance of the engineer. The latter must know how to discriminate between castings, and must give the selected foundry every opportunity to reach his standard. He is at fault, more than the foundryman, for castings going to the wrong place, for the foundry can only supply its own product, whether it is satisfactory or not, while the engineer, knowing his own requirement, should know whether the foundry can give him what he wants.

Foundry products have improved considerably during recent years, and it can truthfully be said that (slowly perhaps) the foundry is approaching the engineer's standard. What remains to be done is to classify the standards so that there will be no ambiguity, and then classify the foundries, so that each knows its prescribed standard, and can develop its resources accordingly, and in this way the engineer in every sphere of industry will get satisfaction, because the danger of castings going to the wrong place will be obviated.

The Deposition of Nickel.

In the course of a Paper on "The Uses of Nickel Deposits for Engineering Purposes," read recently by MR. C. H. FARIS before the Institution of Engineers and Shipbuilders in Scotland at Glasgow, the author referred to the electrolytic process of nickel deposition, worked cold on the "Still" principle.

To demonstrate the degree of adhesion between a coating of nickel and the object treated, the author referred to a test carried out on a 1-in. steel plug built up by deposition of nickel; then a fine-pitch screw having 40 threads to the inch was cut upon the nickel, the final diameter over the tops of the threads being $1\frac{5}{32}$ in. The length of the portion carrying the nickel was, at the commencement of the test, 1 in., the maximum thickness of deposit at the thread tops 0.078 in., while the minimum thickness at the root of the thread was 0.062 in. A $\frac{3}{4}$-in. Whitworth standard thread was cut on the other end of the steel plug, on which was fitted a steel holder, another steel holder being fitted to the already-mentioned fine thread on the nickel. The specimen was then subjected to a pull in the same manner as a tensile test-piece would be pulled. At a load of 10 tons per sq. in. no breaking down of the adhesion was observable.

With the object of reducing the pull required, the superficial area was reduced by turning away the nickel until the former length of 1 in. became only a narrow collar 0.215 in. in width. Again the load was applied to the test-piece in the manner described, and at a load of 6.74 tons the thread of the steel holder, which was attached to the 40-thread screw on the nickel, sheared and left the test-piece, the nickel thread remaining intact. The steel holder which failed showed, under a scleroscope test, a hardness number of 28.

To carry the test to finality a special steel holder was employed, which, instead of fitting on to the fine thread, placed the load directly upon the end face of the nickel deposit. At a load of 11.95 tons the ring of nickel was pushed from the steel plug, and subsequent calculation showed that the required pressure to move the deposit was 17.6 tons per sq. in. The nickel came away from the steel in the form of a ring, broken at one point only in its circumference, and on the inner surface a film of steel was found to be amalgamated with the nickel, proving that even at the load stated the adhesion was greater than the skin of the steel could withstand; thus the steel sheared.

Reports and Dividends.

United Strip & Bar Mills, Limited.—Loss, £1,722.

Falkirk Iron Company, Limited.—Interim dividend, 4 per cent., actual, less tax, on ordinary shares.

Sheepbridge Coal & Iron Company, Limited.—Interim dividend, 6d. per share on ordinary and preference shares, and 2.4d. on partly-paid preference, less tax.

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Machine Moulding.*

By W. J. Molyneux.

It is proposed to consider what exactly machine moulding is, why the practice of making moulds by mechanical means was instituted and developed; on what lines and to what extent that development has progressed; and, finally, to examine what are the possibilities of further development.

In a general way, when a person speaks of machine moulding, he means the performance by mechanical means of *one* or *more* operations in the making of a sand mould for the production of a casting in metal. (The author is unaware of a machine that will perform automatically *all* the operations.)

The main reasons for the institution and development of machine moulding may be summarised as follows:—(1) To cheapen production: (2) to meet the ever-growing demands for more uniform castings in increasingly larger quantities; and (3) to enable the founder to attain a higher degree of accuracy than is possible with hand moulding.

The aim of the designer should be for the moulding machine to:—(1) Give the largest output of moulds for a given expenditure of labour and material; (2) to decrease the total cost of the article produced; (3) to make possible the attainment of the highest degree of accuracy and uniformity in the castings; and (4) to benefit the worker through the performance, mechanically, of the greatest number of operations.

In the early types of machines one operation only, such as the drawing of the patterns, was performed, and that by hand power. Then there came the machine that would give a final squeeze to the mould, the squeezing being done by a system of levers, thus enabling the operator to exert a comparatively great pressure on the mould top similar to the conditions existing in some present-day machines. Later on there was the power-operated machines, and, step by step, progress can be followed until one arrives at the modern machines, some of which will do most of the operations automatically on simple moulds.

In one instance, at least, the sand is riddled and delivered into the flask by a self-contained conveyor, the mould rammed and the pattern drawn. All that is required of the operator is the placing of the flask and bottom board, the starting of the machine, and the taking away of the mould part.

Motive Forces for Moulding Machines.

Before reviewing some of the main types and makes of machines at present in use, something should be outlined as to the relative merits of compressed air, hydraulic power and electricity in their application to machine moulding.

Compressed Air.

Compressed air is perhaps the most widely-used agent, at least, in this country, and has much to recommend it. It is generally used at 80 to 100 lbs. per sq. in. pressure. The air under pressure is conveyed through pipes to the machines. Against this there is the exceedingly low efficiency of the compressed-air plant. It is thought that at a generous estimate the efficiency is not more than 55 per cent., which means that for every unit of energy available for use at the receiver almost another one is lost in overcoming friction in the moving parts of the compressor. Heat generated by the friction of the air during compression, and which is dispersed by circulation of water round the cylinders and valves is characteristic of this. Air cannot be used satisfactorily at higher pressures, which means that the limits of application of the air squeezer are much narrower, than, say, those of the hydraulic machine; also the cylinders and pipes need to be much larger than with hydraulic power where much higher pressures are used.

Hydraulic Power.

The hydraulic pump and accumulator is a much more efficient plant than the air compressor, the efficiency running as high as 85 per cent., which means that for every unit of energy available for use, about ⅛ unit is consumed in the generating plant. For pattern drawing hydraulic pressure is very much more positive and steady than compressed air.

As to leakages, it is doubtful where the advantage lies, as with air, leakages are either not noticed or are neglected, resulting in heavy power losses; whereas with water, leakages are readily seen and *must* be attended to. It is thought that considering all things the advantage is with water.

Electric Power.

Electricity used direct on the machine is not employed extensively, although it has much to recommend it. Such a machine can be quickly and cheaply connected to the source of supply, and in case of a breakdown, generally only one machine is affected.

Classification of Moulding Machines.

Speaking broadly there are two distinct groups of machines: (1) Hand-operated machines and (2) power-operated machines. In considering the merits and demerits of the two groups, they can be conveniently classified according to their chief characteristics. While it is necessary to have several kinds of machines to cope with the many and various moulding propositions, there is considerable overlapping and conflict of opinion as to general utility.

It is not desirable to have many distinct kinds of machines in one foundry, as unless the flow of work through the shop is very uniform, machines are frequently out of balance. It should be possible to transfer work from one machine to another within limits.

Hand Machines.

The operations performed by hand-operated machines usually fall under the following heads:—(1) *Squeezing the Mould.*—This is usually done by a lever or system of levers by means of which an operator can put the required pressure on a mould up to a certain area, or the required mechanical advantage is obtained through a train of gearing by turning a hand wheel as in the Britannia squeezer.

(2) *Turning over.*—This is done either by trunions or the pattern-plate carrier, or the whole is rocked over as in the Pridmore machine (portable type).

(3) *Pattern drawing.*—This is effected by drawing the pattern downwards or pushing the box off the pattern, or with the turn-over machine, by drawing the pattern upwards or lowering the mould off the pattern.

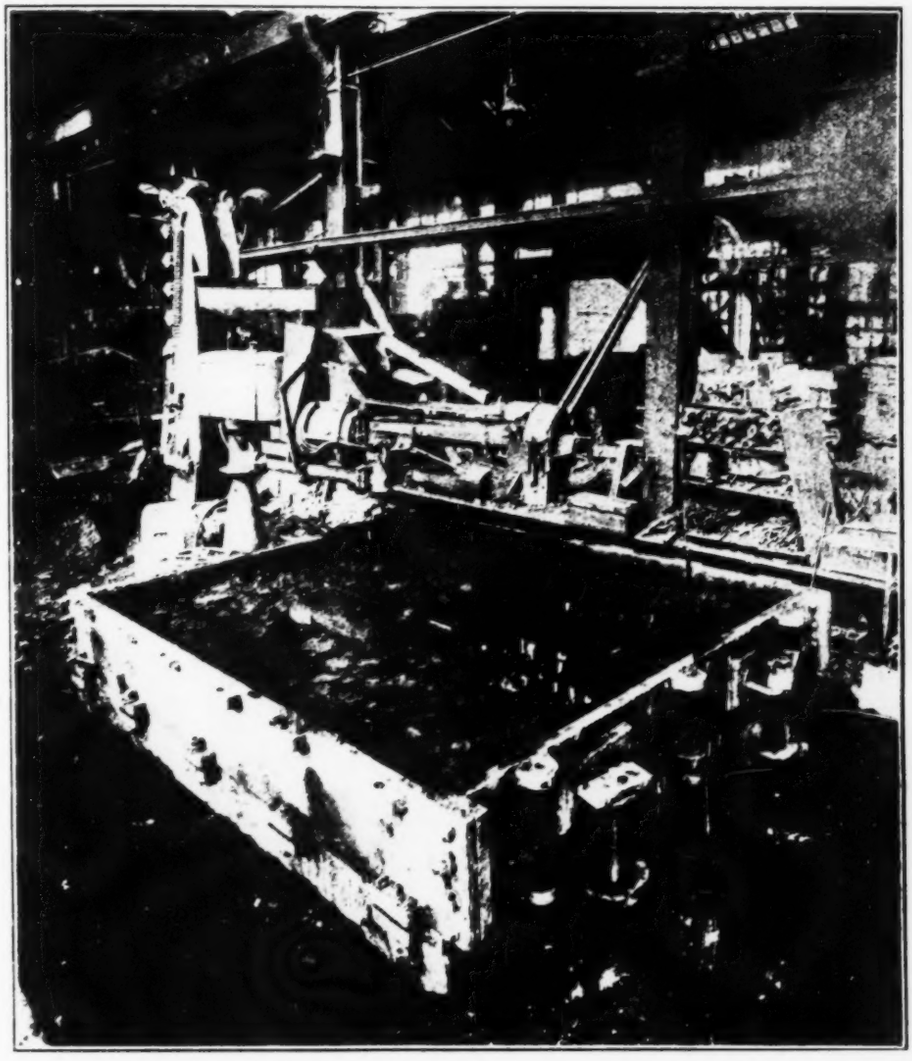

FIG. 1. THE SAND SLINGER INSTALLED IN THE WORKS OF CLARKE, CHAPMAN & COMPANY, LIMITED.

* A Paper read before the Middlesbrough Branch of the Institute of British Foundrymen, Mr. F. Wilson presiding. The author is on the staff of Messrs. Clarke, Chapman and Company.

Power Machines.

In the power-operated machine from 1 to 4 or 5 operations can be performed mechanically. The most popular machine in this country and in America is perhaps the jar-ram machine. The scope of this machine in all its forms is the widest of all the power machines. In all jar-ram machines, the pattern and moulding box and sand are lifted by mechanical means and then let fall on to an anvil (or assisted in falling as in "Pneulec"), this causes the sand to fall vertically and pack to the required density round the pattern. The density is regulated by the number or the intensity of the blows or jars in the ramming.

The jar-ram machine in its simplest form, namely, the machine which performs one operation only can be used for jolting single or plate patterns, which are afterwards drawn by hand. It is often advantageous to make quite small quantities in this way. In the larger sizes these machines are generally let in flush with the foundry floor. These machines are also very suitable for core-making, and are frequently let in flush with the bench tops.

The next step in the development of jar-ram machines is the addition of a pattern-drawing device, with perhaps also provision for vibrating the pattern.

The latest development of the jar-ram machine is the turn over type. In this machine four operations are performed:—(1) Ramming the mould; (2) turning over of pattern and box (clamp box); (3) vibration of pattern; and (4) withdrawing of pattern, as in Osborn machine or lowering of mould as in Britannia.

The great advantage of jar ramming is the comparatively even ramming possible on suitable jobs. Deep jobs are far better done on the jar-ramming machine.

The sand should be worked as dry as possible so as to allow it to pack properly. The sand tends to be harder nearer the pattern plate and soft toward to top when rammed. Undercut portions do not ram satisfactorily on the jar-ram, and loose pieces are generally left in the mould and tucked by hand afterwards, or the undercut part is cored out. Much more coring is often necessary with patterns used on these machines.

Power Squeezers.

The squeezer machine, either for air or hydraulic power, is extensively used both in Europe and in America. It has much to recommend it, and on suitable work is capable of producing moulds at a very fast rate. The scope of the air squeezer is rather limited, because of the relatively low pressure at which air is used. Its application to the squeezing of large moulds is ruled out on account of the size of the cylinders, etc. However, for simple work, such as 18 in. × 12 in. boxes the air squeezer is an exceedingly handy machine. It is mostly used on shallow plate-work, although deeper jobs can be dealt with by using a temporary ramming block, with which the mould is pressed in two or more operations. To deal with deep patterns it is sometimes found advantageous to employ a machine that first jolts and then gives a final squeeze to the mould.

Of the squeezer machines, those arranged for hydraulic power have the largest scope, besides being more economical to run. The hydraulic squeezer can be used for the smallest moulds up to moulds of considerable size.

One of the greatest disadvantages of the squeezer machine is the fact that the mould is hard near the pressure plate and softer near the pattern. Generally speaking, this condition of affairs is just opposite to what is desirable and what is actually attained in the jar-ram machine.

This difficulty has been very satisfactorily overcome by the Universal System of Machine Moulding Company, Limited. In the making of medium and deep moulds what is known as a down-sand frame is employed. With this device the outside of the pattern plate is made in size, roughly speaking, to the inside of the moulding box, and is attached to the hydraulic plunger. A cast-iron frame, the inside of which is the same size as the outside of the pattern plate, and of a depth determined by experience, is supported at a certain height relative to the pattern. This frame carries the pins or lugs to receive the moulding box. The moulding box is then put on and filled with sand. The adjustable top plate is arranged to operate on the moulding box, and when the pressure is applied, the box and down sand frame are held by the top plate, and the pattern is pressed into the sand until the moulding box joint is level with the pattern plate. It will be seen that with this arrangement a top sand frame is not wanted. Also, if the moulding box has its sides leaning inwards towards the top the sand is to some extent pressed sideways. On return stroke the down-sand frame draws the pattern.

It should be noted that as with the jar ram machine, so with the squeezer, the flow of the sand is much better when worked as dry as possible.

The Sand Slinger.

This machine was developed in the U.S.A., and employs an entirely new principle in machine moulding, that of throwing or slinging the sand—3,000 to 6,000 ft. per min. For certain classes of work the machine is very rapid in operation, and on some repetition jobs is faster than any other type of machine. It will ram 7 to 10 cub. ft. per min., but much of its success, however, depends upon the facility with which the sand and moulds are handled, and when working in conjunction with other machines for drawing the patterns, so that the sand slinger is kept in continuous operation, some very good results are obtained. In the jobbing foundry, however, the scope of the machine is limited to the ramming of medium size and large work of a suitable class.

The machine is of robust construction, all bearings are dust-proof, and motors are totally enclosed. The wearing parts (apart from the sand belt), are easily and cheaply replaced in one's own foundry. After some three years' experience the author has been surprised at the almost trivial nature of the repairs and renewals.

Patterns.

In great measure the success of machine moulding depends upon the provision of accurate and well-made patterns and pattern plates. In many cases it is essential for the pattern to leave a mould requiring absolutely no hand finishing, with all rammers and risers formed by the pattern plate.

The type of pattern used and the material used in its construction is determined by its size, the class of machine it is to be used on, the quantity of castings required, and whether it is for permanent use. It is often profitable to use machine moulding for quite small quantities. The materials most generally used are (1) wood or wood reinforced with metal; (2) cast iron; (3) gunmetal; (4) aluminium; (5) various white metal alloys of low melting-point and no contraction; (6) stone-like compositions, and (7) plaster of paris, etc.

Moulding Boxes.

Moulding boxes must be strictly interchangeable; have accurately-fitting pins usually; have machined joints, and must be kept in good repair, if clean, accurate and profitable work is to be done. There are many cases on record of good machines having been condemned as failures, when the real cause of failure has been one of the following:—(1) Faulty or unsuitable patterns; (2) faulty or unsuitable moulding boxes; (3) the machine has been unsuitable for the class of work, and (4) lack of ability or apathy on the part of those responsible for the operation of the machine.

Conclusion.

In conclusion, it may be profitable to probe a little into the future. What are the prospects of further developments in the moulding machine? When one examines the brilliant developments of machinery in some branches of business, one is forced to admit that the moulding machine has not by any means reached finality. That triumph of engineering skill, the Linotype machine, stands out as an example to be emulated, as also does the modern printing machine which prints the daily papers and delivers them ready folded. Even in engineering machine shops the work being done on, say, automatic lathes, where a machine part is finished complete to fine limits quite automatically, there are outstanding cases. It is thus realised that there is still ample room for progress in the foundry machine.

Regarded from the standpoint of the casting of non-ferrous metals, there it is found that at least in the case of aluminium the permanent mould or die is slowly superseding the sand mould for many jobs. The progress is quicker, the casting more accurate, and the physical properties of the metal much better. In one large aluminium foundry motor-car engine crank cases are made in about five to seven minutes' each, by a gang of six men. The problem of long-life moulds is being seriously and successfully tackled, whilst in other directions there is greater use being made of drop forgings and pressings, in preference to castings.

Whilst the last generation has witnessed much progress in the application of machinery in the foundry, it is confidently expected that there will be a further movement forward—bigger and more difficult problems will be tackled, and solutions found for them.

In the brief discussion which followed, MR. A. G. HARRISON asked whether a satisfactory moulding machine had been made for producing railway chairs, and MR. MOLINEUX replied that in this country up till now the work could generally be performed best by hand. Another speaker commented upon the cost of the upkeep of a sand slinger, but Mr. Molineux maintained that in his experience over several years the cost of this was quite low.

Calendars, etc., Received.

We have received from **Newton, Chambers & Company, Limited**, Thorncliffe Ironworks, near Sheffield, a definitely useful daily tear-off wall calendar. From **British Pig-irons, Limited**, of Abbey House, Victoria Street, London, S.W.1., a monthly tear-off wall calendar surmounted by a coloured picture of a girl's head. From **T. Fearnley, Allen & Son**, 51, Norwich Union Chambers, Congreve Street, Birmingham, a monthly turn-off wall calendar, each leaf containing matter describing and illustrating sand-blast plant. From **British & Continental Traders, Limited**, a diary, which contains a large amount of technical data which has been augmented since last year. As the diary contains a request for suggestions for improvements, we submit that "elements" should replace the word "metalloids," and that the caption "Tensile Strains—Equivalents" should be replaced by "Tensile Stresses—Equivalents." **Watson's (Metallurgists), Limited**, Lancaster Street, Sheffield, a seven-page to the day diary with cash ruling interleaved. From the **Staveley Coal & Iron Company, Limited**, Chesterfield, a combined diary and technical note-book (entirely separated). No less than 64 pages are devoted to the setting out and illustrating technical data plus a certain amount of interesting matter relative to the production of the works. From the **Stanton Iron Works Company, Limited**, near Nottingham, a seven-day to the page diary, containing 67 pages of technical and descriptive matter relative to the activities of the works. From **J. Stone & Company, Limited**, Deptford, London, S.E., a waistcoat pocket diary. From **H. G. Sommerfield & Company, Limited**, Charterhouse Chambers, Charterhouse Square, London, E.C., a pocket diary, with a very pleasing binding. From **Lunt Brothers**, Colmore Row, Birmingham, Foundry Coke Merchants, a monthly tear-off calendar.

German Locomotives for South Africa.—The Railway Administration of the Union of South Africa has accepted German tenders for the supply of 90 locomotives, costing £560,213. Firms in Great Britain, the United States, and Italy were among the tenderers, but the contract was divided between six German firms, after giving the fullest consideration to the various proposals submitted and also taking into account the various conditions governing the respective tenders, quality of material, and workmanship. The British prices were about 25 per cent. above the Germans.

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Are Our Coke Ratios Too High?

BY OUR METALLURGICAL CORRESPONDENT.

The coke consumption is the most prominent item in the melting cost charges, and the possibility of saving in this direction has always intrigued the enthusiastic foundryman. The most common method amongst foundrymen of expressing coke consumption is in the form of a simple ratio between the amount of coke used and the amount of iron melted. In spite of the more modern tendency to express this ratio in the form of a percentage there is no doubt that it is the simplest and most generally understood. Whatever the manner in which the coke consumption is expressed very little investigation is necessary to show that this apparently simple and direct practice is not the most definable of the many indefinite practices in the foundry. Many complications arise which still provide some of the most controversial points in foundry discussions.

The question as to the legitimacy of the inclusion of the amount of the bed coke in the coke ratio, formerly a contentious point, appears to be settled by general consent, and the commonly accepted coke ratio is understood to include the whole of the bed coke. Strictly speaking some of this coke is recovered from the dump, and the amount thus recovered should be deducted from the total to obtain the correct ratio. This is, of course, done in thermal efficiency investigations, but it is much too difficult and laborious a task in daily melting practice.

Class of Work Dominant Factor.

The coke ratio cannot be considered apart from efficient melting. The cupola as a melting unit is desired to provide iron to meet the needs of the foundry; one of the most important of which is that the molten metal shall be sufficiently superheated successfully to run the various castings. No theoretical dissertation is necessary to convince anyone that the higher superheat requires more heat and consequently more coke. Efficient melting from this point of view will vary considerably in individual foundries according to the class of work and the composition of the metal melted, *i.e.*, whether fluid phosphoric iron or low phosphorus material. It is obvious, therefore, that if there is one consideration which cannot be omitted in the comparison of coke ratios it is the temperature of the molten metal produced.

Our consideration of the question of coke ratio and economy are often confused by the statements of the theoretical limiting coke ratio appearing in many text-books. This is variously stated, and a typical example taken from a most carefully written treatise on foundry practice is as follows:—"The heat generated by a pound of carbon should be capable of melting about 40 lbs. of iron if the combustion were complete and the absorption perfect." This coke ratio of 1 to 40 or 2½ per cent., in spite of its careful definition with respect of the completeness of combustion and heat absorption, is based on the assumption of pure carbon as fuel and the whole of the heat evolved in the combustion being completely absorbed by the iron to be melted. To translate this into foundry practice it means that a coke ratio of 1 to 40 would be obtained using pure carbon as fuel, with the escaping gases containing no free carbon monoxide and at the same temperature as the atmosphere. Clearly these conditions do not represent conditions attainable in practice. The presence of 12½ per cent. ash in the coke, not an infrequent percentage, reduces this coke ratio to 1 to 30 with a tapping temperature of the molten metal of 1,450 deg. C. It is impossible to burn coke in shaft furnaces without the formation of some carbon monoxide, and the escaping gases to issue from the cupola throat without carrying away some sensible heat. Some heat must of necessity be absorbed in the formation and the melting of the slag and in heating and radiation from the furnace lining. All these sources of heat absorption are inherent features in all cupola practice and must be taken into consideration in determining the theoretical limit of coke ratio obtainable in *cupola practice*. They have the effect of reducing the coke ratio still further. The determination of this theoretical limit involves a determination of the theoretical thermal efficiency, which in its turn involves a consideration of the limiting conditions of all the various sources of heat absorption. Of these, by far the largest source of heat absorption, other than the melting of the metal, is that of the sensible and latent heat taken away by the escaping gases. Unfortunately the minimum limit of the amount of heat taken away in this manner is still more or less indeterminate, owing to the incompleteness of our knowledge of the course of the combustion reaction. The whole subject has been carefully reviewed recently by Thompson and Becher, and from the relationship derived they have estimated a gross thermal efficiency of 52.6 per cent. for a cupola operating under quite good conditions. This is a figure which is higher than many of the experimentally determined efficiencies and reduces the coke ratio from the previously-mentioned values to about 1 to 18, or approximately 5½ per cent. This is with a coke of an ash content of 12½ per cent.: a better ratio would, of course, be obtained with a lower ash content. Incidentally these coke ratios are theoretical and do not include the coke which is not burned and would be recovered from the dump. On a practical basis to include this, the ratio would be somewhat higher, depending upon the capacity of the bed.

Piwowarsky's Findings.

A very common practical coke ratio is 1 to 10, or 10 per cent., and broadly speaking, a foundry operating on this basis with average cokes considers that it is not doing at all badly. Better ratios than this are obtained in certain cases, 1 to 12.5, or 8 per cent., being fairly common in certain cases. In this connection one cannot help but be interested in the careful experiments of Piwowarsky and his collaborators (*F.T.J.*, August 13, 1925) and it is entirely due to the restudy of these results which prompted the question raised in the title of these notes. A study of these experiments carried out on a comparatively small cupola of 39-in. dia. shows that a coke ratio of approximately 1 to 16, or 6.29 per cent., could be obtained without any serious falling off in the tapping temperature of the metal. The method followed by Piwowarsky in determining these conditions for the particular cupola, occupied two stages. Firstly, operating with an approximately constant coke ratio the optimum conditions of blast quantity were determined from the determination of the thermal efficiencies. In the second stage operating with this optimum blast volume the coke ratios were varied, and the low limit of 6.29 per cent. was apparently fixed by the observed commencement of the lowering of the tapping temperature of the metal. Two of the conclusions are of sufficient interest to repeat verbatim, as follows:—"(*a*) In each case the consequences of an excessive coke charge are more detrimental (to the thermal efficiency) than the consequences of too little air or a slight excess of air and (*b*) the fear that the reduction in the charge coke might cause increased losses is only founded where the charge coke is below 7 per cent."

Further Economies Possible.

These results and conclusions are very significant, particularly when the comparatively small diameter of the cupola is taken into consideration. The amount of heat lost to actual melting by way of sensible and latent heat in the gases issuing from the throat has prompted various proposals with the object of diverting some or all of this to the actual melting. The credibility of some of the values of coke ratios claimed is very frequently a matter of suspicion, but, in this country at any rate, some of the most sanguine claims are no better than those obtained by Piwowarsky under similar conditions. The low ratios which appear to be possible from the scientific determination of the most economical conditions in a given cupola, coupled with the fact that coke charges are still a matter of personal judgment on the part of the cupola attendant in many cases, raises the question at once: "Are our coke ratios too high?" It appears conceivable that even to-day careful analysis of normal cupola practice will be repaid by still further saving in coke.

South African Iron and Steel Bill.—According to a cable there is an impression existing in certain circles that the Iron and Steel Bill may undergo material changes before Parliament reassembles.

The Machinist in the Pattern Shop.

BY BEN SHAW.

To an enterprising machinist no workshop offers more scope for his inventive genius than the pattern shop. The work is more exacting, and of a more varied character than that done in the majority of other wood-working shops. No one can increase the efficiency of a pattern shop so well as a good machinist working systematically and with initiative.

Patternmakers are, as a rule, notoriously lax in taking the fullest advantage of machinery, yet the successful use of machinery not only reduces the cost of their work, but, by eliminating the hard labour, makes the turning out of patterns a more comfortable occupation than it would otherwise be. At one time there was continual friction between machinists and patternmakers. The latter seemed to resent the machinists using the machines, maintaining that they were merely occupied in keeping the machinery in order, the actual cutting of the wood for patterns being patternmakers' work. This view is, however, gradually being displaced for a more reasonable one which recognises a more friendly spirit towards the machinist and his work.

There is much bench work in connection with this interesting trade, but much of it can be simplified by attending to constructive details so as to get the best results from machinery installed in the shop. These should be worked to their utmost capacity, and a good machinist can augment the output by creating in the minds of the patternmakers a knowledge that work entrusted to him will be done accurately and well, and as expeditiously as circumstances will permit. Only by encouraging this confidence in his work will he be able to create that good feeling which should exist to obtain the best results. Just as he proves his ability so will his opportunities increase in effectively co-operating with the patternmaker in obtaining the best work from the machinery.

To be successful, it is of primary importance that all machines be kept in perfect order. The surface planer or jointer is of little value unless it is capable of giving a level finish to the timber. It should be possible to make a perfect glued joint direct from the machine. The thicknessing machine is required to make the timber parallel, so that segmental work can be built up without the necessity of dressing off each layer before attaching the next layer of segments. Then, in connection with this machine, it is advisable to remember that the dimension indicator should be represented by a contraction rule, or, at least, the machinist should recognise the fact that an allowance must be made for the contraction of metals. The amount that a metal will contract when cooling from a fluid condition varies according to the particular metal to be used and the ability to make suitable allowances will enhance his reputation. If a double-edged rule is fixed to the machine to indicate contraction measurement for both brass and cast iron, it would prove an excellent guide.

The band saw requires his special care, as on this machine he is able, in a greater measure, to demonstrate his efficiency. He is in great demand for all the special cuts which necessitate special care. It is well to anticipate such cuts and have at least two sharpened saws in reserve. The same suggestion might be useful respecting circular saws. A first-class machinist is always in great demand in a pattern shop, especially in the more modern shop where the patternmakers more fully realise and appreciate his services, and term him the general utility man. Not only is a good machinist valuable in manipulating and keeping various machines in order, but he can be very helpful with suggestions during the construction of an awkward job so that the maximum use may be made of the machines that are available.

Roman Ironworks in Sussex.—The Roman furnace farthest north in Sussex for smelting iron has recently been discovered close to East Grinstead by Mr. Ernest Straker, of Purley, who is making a study of the past history of the iron industry in the South of England.

XUM

Foundry Purchasing.—XVIII.

By Eric N. Simons.

In addition to the difficulties of the sectional catalogue from a library point of view, there is the difficulty of properly indexing the added sections or pamphlets when inserted in their proper binders in the buyer's catalogue library. If a simple alphabetical system is adopted, no particular difficulty arises; but when the method adopted is more complex, as with the big libraries of many firms, the answer is not easy. For example, if the separate pieces are numbered, the latest jarring-machine catalogue issued by John Smith & Company may be numbered 100, and No. 101 be something altogether different. If a still later stonebreaker catalogue comes from John Smith & Company, it has to be filed between 100 and 101. The already long reference number has to be further lengthened by the addition of a small letter, *e.g.*, 100 (*a*) to indicate the rearrangement. It is needless to dwell on this problem unduly, since it is but a minor one, and can be overcome without much fuss in the manner shown. But it is important that sectional catalogues, whatever may be the buyer's opinion of their wisdom, should be properly and regularly filed in the binders provided for them by their publishers. The way to ensure this is to delegate the work to the one responsible person who, in the writer's opinion, should be the statistical clerk (where no separate librarian is employed). He should be censured in the event of any pamphlet or catalogue being missing from the sectional file.

Enough has been written on the subject of catalogue-filing. Some reference to the means of expressing statistics in summarised form must now be made. While the detailed records have to be kept because the essential conclusions could not be obtained without them, it is not always necessary for the buyer himself to wade through column after column of figures and facts. What he principally needs is to make sure that the essential records are at hand, for consultation in detail if required; but for his own use, and that of his superiors, he will want summaries of the records. Examination of these will enable his trained judgment to extract the main data, and to form opinions on which his recommendations will ultimately be based. It is important, therefore, that charts and graphs embodying the transactions of a year or shorter period of time should be accurate, clear, and comprehensible. There is, of course, no one royal road to the presentation, in readily digestible form, of buying facts. Different kinds of records have to be treated in different ways. Some directorates detest graphs, and will only deal with tabulated columns of figures. Others detest tables of figures, but can follow a graph or curve with ease. Much depends on the character of the business, and on the training of the men conducting it. In addition, the buyer will probably have his own pet scheme for the summarising of data. In these circumstances, it is impossible for the writer to assert dogmatically that one way is better than another. Fig. 1 shows a simple table recording the deliveries of raw materials during one week. The names of the port or station, and of the material, are followed by the total weight, the price per ton, and the total value:—

Deliveries of Raw Materials Week Ending February 17, 1927.

Name.	Material.	Weight.	Price per ton.	Total.
				£ s. d.
Middlesbro' ..	Pig-iron	29 tons	92/6 plus 11/3 carriage.	150 8 9
Henry Mead..	Sand (ex-Goole)	192 ,,	31/- d/d	297 12 0
Bawtry ..	Sand	9 ,,	7/- plus 6/4 carriage.	6 0 0

FIG. 1.—PORTION OF SIMPLE TABLE RECORDING DELIVERIES OF RAW MATERIALS DURING ONE WEEK.

Figs. 2 and 3 show two methods of presenting the same data. Fig. 2 records in tabular form the consumption of coal by a certain foundry over two entire years, month by month and quarter by quarter, with the type, weight, and price of each lot. Fig. 3 shows exactly the same figures, but in a different way, occupying less space and being more convenient to read.

It must not be assumed that the use of graphs or curves dispenses with the need for tables. The truth is that they are complementary. The one brings out striking features that the other might conceal, and *vice versa*. In brief, the difference between them is roughly this: Charts (*i.e.*, graphs and curves) indicate broad tendencies and changes (*e.g.*, prolonged rises, sudden falls, steady decreases, regular movements, sudden fluctuations) more quickly than do tables and lists. In other words, they dramatise the facts, presenting them boldly and succinctly. Tables, on the other hand, indicate discrepancies and points of detail more clearly. For example, a chart might indicate that prices showed a general tendency to remain steady during a given period; but a table embodying the same facts might reveal that the occasional rises in the curve were due to emergency purchases from a different supplier (and so might lead the buyer to prevent the recurrence of similar emergencies as far as possible). Both forms of summary are valuable, and neither should be abandoned in favour of its fellow.

Coal.

Quarters.	Month.	Name.	Weight. Tons. cwts. qrs.	Price.	Quarters. Total. Tons. cwts. qrs.
1919: 1st ..	January	Bolsover hards	193 16 0	26/7 ton	
	February	,, ,,	194 14 0	,, ,,	
	March	,, ,,	144 5 0	,, ,,	
					532 15 0
2nd ..	April	,, ,,	124 12 0	,, ,,	
	May	,, ,,	157 0 0	,, ,,	
	June	,, ,,	130 16 0	,, ,,	
					412 8 0

FIG. 2.—PORTION OF TABULAR RECORD OF TWO YEARS' CONSUMPTION OF COAL.

	1st quarter, 1919.	1st quarter, 1920.	1st quarter, 1921.	2nd quarter, 1919.	2nd quarter, 1920.	2nd quarter, 1921.
Sutton and Cresswell cobbles ..	144.11	98.17	50.15	—	—	—
	214.7	144.17	144.8	—	—	—
	179.17	215.7	@ 40/3	—	—	—
	@ 27/3	@ 33/10	—	—	—	—
	888.11.0	518.4.0	195.3.0	—	—	—

FIG. 3.—PORTION OF TABULAR RECORD OF THREE YEARS' CONSUMPTION OF COAL.

Metal Thieves.

BY "ONLOOKER."

From time to time our newspapers report thefts of metal from warehouses, yards and railway sidings, but in spite of the convictions obtained, the pilfering persists, and traders, manufacturers and public carriers lose thereby every year considerable sums.

This nefarious trade is carried on from January to December, but with the coming of short days, and more especially, with fog as their ally, the metal thieves find better opportunity for carrying on their exploits in winter than in summer. This factor applies mainly to thefts by gangs, who seek to avoid capture by keeping on the move, but the dishonest employee of a metal works or scrap dealer need not, of course, concern himself with facilities for a getaway, for, so long as he can avert suspicion, he is able to continue his dishonest practices unmolested.

Some years ago a case of stealing from a metal works was reported, in which suspicion had first been aroused by the man wearing an overcoat winter and summer, in the pockets of which pounds of copper, spelter and brass were disappearing every week. Other dodges worked with success have been the carrying off of wire coiled round the body under a man's clothes, and the use of a hand-bag purporting to contain a dinner basin, but in reality concealing stolen metal in one form and another. The man's devotion to his pudding basin drew suspicion, and being judiciously hustled one day, he dropped the precious cargo, which proved to be nothing less than block tin.

This underworld traffic in stolen metal is, of course, only made possible by the existence of the "fence," or receiver, who, usually posing (and carrying on business) as a metal merchant, deals extensively with these light-fingered gentry. Among "the brotherhood" prices are paid which bear no relation to the true value of the metal, and contract notes are not exchanged! No particular place of business exists which can compare with 'Change, but deals are arranged under cover of a friendly glass in the bar of some not too respectable place of refreshment, where members of a gang may see each other in comparative safety. Needless to say the "fence" comes pretty well out of every bargain, and he would need to, for his is the biggest risk, and he knows it.

Owing to the comparative ease with which it can be identified, virgin metal in ingot and slab form is not popular among metal thieves, who much prefer scrap in its multifarious forms and guises, for once a mixed parcel of old material has been dumped and judiciously mixed among the contents of a dealer's yard, recognition is difficult and proof of guilt well-nigh impossible. Scrap is, of course, of less value than new metals, but it is usually more accessible, for at our railway metal sheds and canal wharves virgin copper and spelter are warehoused under lock and key, while scrap is dumped in the open.

The police alone would usually find it extremely difficult to trace to its source the ill-gotten gains of the receiver of stolen metal, but they can obtain much assistance from warehousemen and despatch clerks of manufacturing firms, especially when finished material is purloined en route to its destination. A very large tonnage of metal goods now travels from the midlands to our seaports by water, and on the lonely stretches of canal it is not difficult to "lift" a bale of wire or a case of sheets.

Manufacturers whose annual stocktaking is practically the only means of ascertaining whether pilfering by employees is taking place, cannot be too strongly urged to take every precaution to prevent this annoyance and loss, by adequate supervision, for a couple of pounds a week on to the wages bill is cheaper than a stock £300 or £400 lower than it ought to have been.

MR. J. A. BUTTERWORTH, a director of W. Newsome & Sons, Ltd., machinery merchants, of Sowerby Bridge, Yorkshire, and formerly head of the commercial staff of Francis Berry & Sons, iron-founders, died on December 19 at St. Leonards. He was 62 years of age

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Institute of British Foundrymen.

Annual Dinner of the Scottish Branch.

The annual dinner of this section was held in the Grosvenor Restaurant, Glasgow, on December 10, Mr. Thomas Bell, Branch-President, in the chair.

Scottish Industries.

MR. VICTOR STOBIE, A.M.I.E.E., of Newcastle-on-Tyne, proposing the toast of "The City and Corporation of Glasgow," referred to the local depression in industry. What was the underlying reason for the lack of orders, and the general lack of prosperity in their yards? He had the impression that a great deal of it was due to the fact that in this country they wanted to give very little service and very few goods for the sovereign. He had a good knowledge of the pre-war Continent, and some knowledge of the Continent in the post-war period. Comparing the industries there and in this country, he thought that by the end of a working day we in Britain did about the same amount of work as they did in these other countries. But the point was that to-day the work—or the service—which the foreigner turned out for a given amount of gold was greater than we turned out. They must realise that unless they were prepared to give more for the money they received, they were really asking for more than they were six or seven years ago, when the sovereign was only worth about 16s. or 17s.

BAILIE PETER BURT, J.P., Chairman of the Tramways Committee of the Corporation, replied to the toast. When he was asked to attend their dinner he said he felt that he was going among a body of men with whom he had been intimately associated all his life, for he was an engineer. Engineers knew all about the foundries and the bad castings they sent them, full of filled-in blow holes. (Laughter.) He thought that at this dinner he would be in a position to get some information as to how to "get back" at the foundrymen. The foundryman always gave them the big pieces first. Of course, the ambition of every ironmaster was to get a really big casting, so as to bring up the average output. (Laughter.)

The proposer of the toast had touched upon the industries of the city. There was no doubt that they were going through very trying times. The burden of rates and taxation was getting beyond anything that was imagined in the past. When he told them that since the war the rates per head of the population in Glasgow had doubled, that gave them an idea of the position. So far as he could see the rates were going to go up still further. He did not think that the commercial men of the city took enough interest in public affairs. He felt that they were not solving their problems. They were pauperising the mass of the people. They had subsidised houses and free education, and in many cases the children were kept. The amount of money that was being spent on these various social schemes was beyond the thought of their ancestors. Yet one could not put these responsibilities aside. There was a certain amount of strength in the claim that if they could not find work for a man they were bound to keep him. They must get to the bottom of the unemployment problem. They heard a lot about competition from abroad, but he had not seen any men better fitted to meet that competition than the men of the British Isles. We were able to hold our own anywhere, but organisation and forethought were necessary. To-day in the foundry trade they had the help of metallurgists and chemists, and they must keep up to date.

Diesel Engines as a Foundry Proposition.

The toast of the "Institute of British Foundrymen" was proposed by MR. JAMES RICHARDSON, B.Sc., M.I.MECH.E., President of the Glasgow Branch of the Institution of Mechanical Engineers. The chairman, he said, had referred to the joint meeting which his Institute held with theirs. He could assure them that that was probably the most successful joint meeting they had in Glasgow, and that the open discussion which they had helped materially to advance some of the problems with which they were both faced. He had looked into some figures to try and assess the extent to which they, as marine engineers, were dependent on the foundry, and he was rather surprised to find that, particularly in the case of a Diesel engine installation, the foundry supplied definitely over 60 per cent. of the total weight. The percentage was probably higher. The cost ratio, of course, was less, probably 30 per cent. He had worked for one or two years in a foundry. He was afraid that the advantage of that training for an engineer was not fully appreciated.

MR. JOHN T. GOODWIN, President of the Institute of British Foundrymen, who replied, referred to the effect of bad trade on the membership of the branches. It caused migration among their members. They found to-day that while they got new members, they were losing old members. If any of them heard of a newcomer in his district, he should try and get him into the local branch, so that what was one branch's loss was another's gain. In spite of what he had said, however, he was glad to be able to tell them that the Institute was increasing its membership rapidly. The figures available up to Demember 6 were very gratifying. There was a happy race going on between their branch and another branch, and to-day the Scottish Branch had just beaten the other branch—London—by about a couple of members. The total membership of the Institute was 1,738. That was a vast increase on anything they had achieved before, and it seemed to him that there was every prospect of that figure being passed in 1928. Invitations from employers all over the country to visit their works were coming in to the various branches. Any man to-day who was a member of the Institute could visit any other work of a similar type, and so get information which at one time he could not get. That was a very good sign.

Value of Co-operation in Scientific Circles.

MR. JOHN CAMERON, J.P. (Past-President), proposing the toast of "Kindred Institutions," said that he had always been proud of the Scottish Branch for the example they had set in their relations with kindred institutions. These relations had for years been of the most helpful character. Mr. Richardson had cited an example of that. They had had a series of joint papers on Diesel-engine work from metallurgists, foundrymen, and engineers, and the discussions had been memorable. Through these joint papers and the interchange of knowledge in other ways the standard of work had improved greatly in the past twelve years.

MR. F. J. SKINNER replied. The time had gone past, he said, when any particular branch of industry could raise a brick wall round themselves. They were interested in any question which interested the engineer and the metallurgist, for example.

Discouraging the Younger Generation.

"The Scottish Branch of the Institute" was proposed by PROFESSOR MELLANBY, D.Sc. He thought that institutions such as theirs would have in the future an even greater influence than they had at present, especially if they could get the younger people to join them. He did not think any serious student of engineering could be satisfied with their present position. He was not referring to the lack of trade or the wretched wages which skilled mechanics had to accept. He referred to the way in which we in this country were dominated by the foreigner. Recent developments were almost all associated with some foreign name. That was very ominous. He thought that the reason was that those in control of industry had lost confidence in the younger engineers. Since he entered the engineering industry he had found a very big change. The whole control in many of the biggest concerns was now in the hands of the commercial men. Such a man was apalled by the technical knowledge of the foreigner, and felt that his own juniors were as ignorant compared to the foreign juniors as he was compared to the foreign expert. That was not the case, and it was in connection with this that such societies as theirs could do much good. Mr. Thomas Bell, whose name was coupled with this toast, was one of the original members of the Scottish Branch, and he had endeared himself to everyone.

MR. BELL, in his reply, said that during the last few years the Institute, like other such institutions, had passed through lean times, but they were on the upgrade now, and there were good prospects of admitting many new members before the end of the year. The activities of the Scottish Branch had grown in recent years. They all knew about the formation of the Paisley section. They had a very enthusiastic set of officials there, and the enthusiasm in the Falkirk section seemed also to be very great. Then there was their new Junior Section. It had only recently been formed, but the signs were very encouraging. Over 300 juniors attended the first meeting, and the second meeting, held in Glasgow, had brought over 100 boys out. At the last meeting the discussion and questions quite put the Scottish Branch in the shade. He did not think they needed to take a back seat, and he had no fears for the future of their branch. (Hear, hear.)

Company Meetings.

Aluminium Corporation, Limited.—The seventeenth annual meeting has been held in London. MR. SAMUEL G. BIBBY, who presided, referred to the Eigiau Dam disaster, which occurred in November, 1925. The rolling mill, he said, though considerably damaged, suffered least, and their efforts were concentrated on supplying customers with sheets and circles, which necessitated the purchase of the required metal at the full market prices. It was a source of considerable satisfaction that, in the face of all such setbacks, extending practically throughout the year, they were able to show a net profit, after paying running costs and administrative charges, sufficient to cover the first debenture interest.

Leeds Fireclay Company, Limited.—MR. CHARLES F. SPENCER, chairman of the Leeds Fireclay Company, Limited, which recently acquired exclusive British rights of the Plasmon process of low-temperature carbonisation, announced at the annual meeting of the company that they had on order a small plant capable of dealing with 2½ tons of coal. This, he expected, would be installed in January, and they intended to use it to test the suitability of different kinds of coal for the process. This process, said Mr. Spencer, resulted in the production of smokeless fuel for domestic and industrial purposes, and of tar or crude oil, which would make us far less dependent upon imported fuels for our Navy and mercantile marine. It was a continuous and automatic process which produced smokeless fuel in large, firm lumps from coal slacks or fines, and the tar or crude oil produced was of remarkable purity and free from coal dust in suspension. He had examined the plant in Germany a month ago, and had been very favourably impressed with its working. Labour and operating costs appeared to have been reduced to a minimum.

Weardale Steel, Coal & Coke Company, Limited.—Presiding over the annual meeting of the Weardale Steel, Coal and Coke Company, Limited, LORD FURNESS said that, although the results obtained during the past year were not so good as they had been accustomed to, he thought they must be regarded as satisfactory, for it was no exaggeration to say that the period through which they had just passed was unprecedented in the history of the coal trade, and many industrial concerns had been brought to the brink of collapse. With regard to the future, proceeded Lord Furness, every effort was being made to modernise their plant and machinery, and keep abreast of the times in order to reduce working costs. As to the prospects of the coal trade generally, he was satisfied that when they had regained their export markets, and provided the iron and steel trade of the country resumed its normal activity, the coal industry would make good. Numerous proposals were being put forward by many doubtless well-meaning people, but what the coal trade needed most of all was to be left free from interference and intervention by politicians and others, thus leaving it to work out its own salvation.

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Trade Talk.

CONSIDERABLE DAMAGE was caused by a fire in the engineers' tool stores at the works of Thos. Firth & Sons, Limited, Corby Street, Sheffield, on December 23.

EDWARD WOOD & COMPANY, LIMITED, of Ocean Ironworks, Manchester, have recently secured several large contracts for the supply and erection of steelwork in various parts of the country, involving about 20,000 tons.

THE ANNOUNCEMENT a short time ago that Sir W. G. Armstrong, Whitworth & Company, Limited, Walker, had entered into negotiations for acquiring another shipyard on the river, related to the yard of the Tyne Iron Shipbuilding Company, Willington Quay. The negotiations are still proceeding.

AT A SITTING of the Falkirk Dean of Guild Court plans were passed for the erection of an addition to the structural fitting shop at the Mungal Foundry, belonging to the Carron Company, Carron, at an estimated cost of £1,000. A petition by R. & A. Main, Limited, Gothic Works, Camelon, to erect a partitioned building to be used as a pickling shop, at an estimated cost of £290, was also granted.

THE FIFTH ANNUAL COMMEMORATION DINNER of the Whitworth Society was held on Wednesday, December 21, being the anniversary of the birth of Sir Joseph Whitworth, Bart. The chair was taken by the president, Mr. Thos. Sugden, and 66 members were present. Interesting notes upon the life of Sir Joseph Whitworth, with photographs, were given by Mr. W. Price, Abell. Subsequently the death was announced of Mr. R. B. Buckley, a past-president.

"In two or three years many of the world's tin mines will be exhausted. The end of the world's supplies of tin is in sight," said Mr. E. J. Byrne, initiator of the tin restriction scheme, commenting on the present agitation in the tin world for the control of prices. "The only way of preventing tin from selling at less reasonably low prices to-day and being dearer than gold in a few years is to control its price. A month ago tin was £258 a ton, and six months previously £310. Yet on each occasion the world's total visible supplies were identical. It is proposed that all mines should agree to control supplies, in order that the price of refined tin should be stabilised, and consequently the price of the freshly mined material. In that way the world's stocks can be eked out to the last at an even price. So great is the need for tin at the moment that, while rich new deposits are being opened up at the Pangnga River, in Siam, at the other end of the world the United States is busy reclaiming tin from old used tinfoil."

MR. R. S. DALGLIESH, the ex-Sheriff of Newcastle and a leading shipowner, has purchased a considerable portion of the steelworks which were owned by John Spencer & Sons, Limited, Newburn-on-Tyne. The company went into voluntary liquidation in the early part of 1925. One section of the works which is concerned with forgings and castings and the making of springs has never gone entirely out of operation, although in late months there have not been many men employed. Again and again there have been rumours of this portion being acquired and reorganised, and ultimately negotiations to that end have been practically carried through with Mr. Dalgliesh at the head. Mr. Dalgliesh has very large kindred interests, having in recent times purchased the undertaking of the Blyth Shipbuilding Company and the engineering works of Blair & Company, Stockton. He also owns the works of Henry Watson & Sons, Walkergate, Newcastle. Mr. Dalgliesh is to have the personal co-operation of Mr. L. D. Dixon-Brown, managing director under the old company.

The twin screw tank steamer "Alicia," built to the order of the Anglo-Saxon Petroleum Company, Limited, by Sir W. G. Armstrong Whitworth & Company, Limited, was launched from the Armstrong yard on December 27. The principal dimensions of the vessel are:—Length between perpendiculars, 305 ft.; breadth moulded, 50 ft.; depth moulded to main deck, 15 ft. The vessel is designed to carry 2,300 tons on 11 ft. 1½ in. extreme draft, and her speed on trial when loaded to this draft will be 10½ knots. She is of the single deck type, with poop, trunk and forecastle, and built on the combined longitudinal and transverse system of framing to Lloyds highest class. She will have a straight stem and elliptical stern. The oil cargo is carried in 5 centre compartments, and 3 side tanks on each side of the vessel. A cofferdam is fitted forward for the full width of the vessel. The propelling machinery consists of direct acting triple expansion type engine, with cylinders 13, 22, 35 by 24 in. stroke, the working pressure being 180 lbs. Two single ended Scotch boilers are fitted. The machinery is being supplied by Shields Engineering and Dry Dock Company, Limited.

G. W. PEARCE & SONS, brassfounders, Bromyard Road, Worcester, were summoned on December 22 for offences under the Factory Acts. The Inspector of Factories said that the regulations required that there should be no grinding, which caused dust, unless there was a hood behind the wheel to take the dust, and a duct and fan to carry it away. Mr. Hemming, defending, agreed that there had been a technical offence. The Bench imposed a total fine of £6 and costs.

LORD BUCKMASTER, the chairman of the governing body of the Imperial College of Science and Technology, presided at the annual dinner, which was held recently in London. Mr. Ormsby-Gore, Under-Secretary of State for the Colonies, in proposing the toast of the College, said he had reason to feel great gratitude for the work that had been done by the College in the past, and was being done to-day. They lived in an age when they required the adventurers in science. Man, when he went to new and unknown countries and sought to harness them to the purposes of civilised life, found that he was met at every turn by new and unknown factors, and by hostile forces. The conquest of those new lands was in the main the work of applying the knowledge of the great thinkers and the researchers—very often men who had never been out of the laboratory—applying their vision to the practical and concrete need of the conquest of natural forces. The first conquests that had to be made in the pursuit of the riches of undeveloped country were those over the forces which threatened human life. The medical officer and the doctor came first, but those men could not be got within the arena of their work unless the material and economic sources of the undeveloped countries could be tapped. It was the master of minerals, the engineer, the agriculturist, particularly to the man who could apply science to agriculture, and to the veterinarian that they must turn for the assistance that was needed. The Imperial College had provided a very considerable proportion of the technical and scientific staff for the geological departments and the mines and agricultural departments of the Colonial Empire. Sir Alfred Mond, M.P., replying to the toast of "Our Guests," said that, while they were getting research in the country at last, he was extremely dissatisfied with the progress it was making. Funds were not being provided on the scale they should be. Unless that were done, and people thought more of the importance of the subject of research, we should fall still farther behind our rivals in other parts of the world. He was chairman of the Fuel Power Committee, a member of which was Professor W. A. Bone, professor of the department of chemical technology, and had had some opportunity of judging what was being done in Germany in regard to the fuel problem. When he contrasted the organisation there with what was to be found here, he really felt quite alarmed and discouraged. While we thought in thousands of pounds, they thought in hundreds of thousands. One firm in Germany had spent well over £1,000,000 on their experimental work in oil and coal. There was a definite shortage of scientific men in this country, and that was hindering research work. In his own company the number of men of the kind they wanted was far below the number they could absorb, and they had decided to approach headmasters with a view to selecting bright boys when still at school. Those boys would be assured that if they would go through a university and obtain first-class degrees, they would not have to look for a job, but would be found one in his organisation, with remunerative salaries, at the moment they were ready to come. The company hoped in that way to do something from the beginning to make science a career just as the Bar or medicine was now. They really wanted a much greater co-ordination between the leaders of science in the universities and those who wanted the taught material. They wanted a conference at an early date so that those who were teaching could be told the directions in which their pupils would find work both of an advantage to themselves and to those by whom they were employed.

Jethro Chambers (Sheffield), Limited, South Yorkshire Ganister Works, Wadsley Bridge, Sheffield.—Capital £4,000 in £1 shares. Objects: To acquire business of manufacturers of and dealers in ganister, etc., heretofore carried on by Jethro Chambers & Company, Limited, at South Yorkshire Ganister Works, Wadsley Bridge, Sheffield. Directors: J. Holland, The Gables, Grindleford, Derbyshire; F. Russell, Auldham House, Worksop, Notts.; J. Chambers, 154, Wadsley Lane, Sheffield. Pickford, Holland & Company, Limited, and the General Refractories, Limited, each have the right to nominate a director whilst holding £200 shares.

Personal.

MR. J. P. MORGAN has been elected chairman of the United States Steel Corporation, Mr. J. A. Farrell has been elected chief executive officer of the corporation, and Mr. M. C. Taylor chairman of the finance committee.

MR. J. M. ALLAN, who has been managing director at Sheffield of Cammell, Laird & Company, Limited, for 14 years, will retire early in the New Year. He is also on the Nottingham board of the company, and is chairman of the Midland Railway Carriage & Wagon Company, Limited, of Birmingham.

MR. GEORGE SCOTLAND, commercial manager of the Falkirk Iron Company, Limited, has been elected chairman of the National Light Castings Ironfounders' Federation for Falkirk and district, in succession to Mr. Andrew Wallace, J.P., of M. Cockburn & Company, who has held the post for the last five years.

MR. R. C. IRWIN, C.B.E., has joined the board of directors of Messrs. Settle, Speakman & Company, Limited, coal, foundry coke factors and shippers, of Stoke-on-Trent, London, Liverpool, etc. Mr. Irwin lately retired from the position of secretary of the London Midland and Scottish Railway Company. He was formerly the secretary of the Lancashire and Yorkshire Railway, and during his period of office with that company was in control of fuel purchases. Mr. Irwin's wide and valuable experience should prove advantageous to the company.

MR. A. O. PEECH, who during the last two years has undergone two serious operations, finds it necessary, on the ground of ill-health, to be relieved of some of his responsibilities, has therefore relinquished the chairmanship of the United Steel Companies, Limited. Mr. Peech will take the position of president and continue to assist the company, retaining his seat on the board. The board has elected Mr. W. Benton Jones to be chairman of the company as from January 1, 1928, and Mr. R. S. Hilton, at present deputy-chairman of the Metropolitan-Vickers Electrical Company, Limited, has accepted the appointment of sole managing director of the United Steel Companies, Limited, as from the same date.

DR. THOMAS STOCKHAM BAKER, president of the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, U.S.A., expects to spend six weeks in Europe during February, March and April of 1928, to organise plans for the Second International Conference on Bituminous Coal at Pittsburgh. The first conference, it will be remembered, was held in November, 1926, under the auspices of the Carnegie Institute of Technology, and was attended by 1,700 delegates and leading fuel scientists from thirteen different countries. The second conference, which will be held under the same auspices, is scheduled for the week of November 19, 1928. The subjects to be considered will include the latest development in obtaining substitutes for gasoline from coal, power from coal, low and high temperature distillation processes, smokeless fuel, gasification of coal, utilisation of coal-tar products, and coal in relation to the production of fixed nitrogen. Dr. Baker's European address, after February 25, will be the Guaranty Trust Company, Paris, France.

Wills.

HARDING, G. F., a director of Spittles, Limited, ironfounders	£56,778
HUGHES, J., of West Bromwich, for many years works manager to George Salter & Company, Limited	£16,973
MUNTZ, SIR GERARD ALBERT, Bt., for many years managing director of Muntz's Metal Company, Limited	£12,784
CURRAN, C. J., of East Grove, Cardiff, managing director of the Curran Metals & Munition Company, Limited	£5,196
KEAY, J. A., Birstall, Leicestershire, president of the Leicester and District Engineering Employers' Association ...	£34,900
HARVEY, A. T., chairman and managing director of the Anderston Foundry Company, Limited, of Port Clarence ...	£58,785
TAYLOR, J., chairman of the British Insulated and Helsby Cables, Limited, of the Colne Valley Electric Supply Company, Limited, and the Midland Electric Corporation or Power Distribution, Limited, and a director of the British Aluminium Company, Limited...	£176,897

IN 1928

WE WILL LAUNCH OUR USUAL CAMPAIGN AGAINST FOUNDRYMEN'S GREATEST FOES BY INCREASING OUR SALES.

MOBILISE NOW

AND BE READY TO "FACE" YOUR ENEMIES WITH CUMMING'S ARMAMENTS—SO THOROUGHLY UP-TO-DATE AND SCIENTIFICALLY PREPARED.

May we send an Expeditionary Force ?

William Cumming & Co., Limited

GLASGOW. FALKIRK. DEEPFIELDS. CHESTERFIELD. MIDDLESBRO'.

TELEGRAMS : "IRON BILSTON."

West Midland Refining Co.,

Bilston.

COLD BLAST IRONS

for Chilled Castings.

Chills and analysis guaranteed.

CHARCOAL REFINED HEMATITES

for Malleable Castings.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Following a practically idle week, the New Year's Cleveland markets were re-opened on Tuesday, but very little actual business resulted, buyers and sellers alike being only sparsely represented; while both are apparently contented for the time being with adhering to a waiting policy, consumers still anticipated a further drop in prices in the near future. Fortunately, at the moment, the Tees-side ironmasters are not embarrassed with big stocks of iron, and if there is the anticipated expansion of business in the New Year, the reserves of iron will be speedily absorbed. The outlook for the New Year, however, is still uncertain. Producers are beginning the year with very light order books. In a few instances consumers have mustered up courage to place contracts over the next three or four months, but low as prices have fallen, there is no general confidence that bottom has been touched, and that lack of confidence influences consumers to buy only from hand to mouth. For the present prices remain as follow:—No. 1 Cleveland foundry, 67s. 6d. per ton; No. 3 Cleveland G.M.B., 65s.; No. 4 foundry, 64s.; No. 4 forge, 63s. 6d. per ton.

The East Coast hematite market appears to have turned the corner to some extent, local producers having of late secured fairly extensive orders from South Wales, while the export business is also on the mend. Prices are steady round 71s. per ton for East Coast mixed numbers and 71s. 6d. for No. 1, but in some cases 6d. less can be done. On the North-West Coast prices remain nominally as previously quoted.

LANCASHIRE.—Although, as yet, hardly settled down on ordinary business lines, the tone of the local markets for foundry pig appears to be moderately optimistic as to prospects for the New Year, and prices, if at all changed, seem a little firmer. Quotations now ruling are about as follow:—72s. 6d. per ton for Staffordshire, delivered Manchester, from 73s. to 73s. 6d. for Derbyshire, about 78s. for Cleveland, from 88s. to 89s. for Scottish, and from 84s. 6d. to 85s. per ton for West Coast hematite.

THE MIDLANDS.—Consumption of foundry material having been only partially resumed during the current week, new orders in bulk have been on a limited scale in the market, with no noteworthy changes in prices reported. Meanwhile, it is not possible to get much concession from the Derbyshire makers. A good tonnage could no doubt be obtained at a few coppers under 65s., and Northamptonshire No. 3 can be bought between 58s. 6d. and 60s. at the furnaces, whilst North Staffordshire No. 3 is between 64s. and 65s. f.o.t.

SCOTLAND.—This being the usual holiday week in Scotland, market business has been virtually suspended, while stocktaking, customary at the end of the year, will occupy at least another ten days. Consequently there has been no variation in pig-iron prices, No. 3 foundry Scotch remaining as previously quoted at 70s. 6d., f.o.t. furnaces.

Finished Iron.

So far as the current week is concerned, resumption of work at the mills and forges in the Black Country has been by no means general, and for the present matters remain much the same as last reported. Manufacturers of crown and common bars are still in an unsatisfactory position as regards new orders, but are hopeful of finding better conditions as soon as the holiday feeling has finally disappeared. Manufacturers of marked bars, having recently reduced quotations to £12 10s. at makers' works, are hopeful of creating a more active demand for this class of material, and are looking forward to the next quarterly meeting to bring an accession of orders to their books. There is considerable competition for the small volume of business emanating from consumers and warehouses for crown bars, and £9 5s. is being accepted from certain directions, and quotations vary from this level up to £10 5s., in some cases £10 10s.

Steel.

The opening of a new year in the steel industry marks little change in the general position, and the impression widely prevails that unless foreign competition can be met on more equitable terms, the prospects of permanent improvement are not encouraging. Prices at Sheffield, meantime, are quoted as follow:—Siemens acid billets are unchanged at £10 per ton, while quotations for basic billets are:—Soft, £6 10s.; semi-hard, £7 10s.; medium, £7 12s. 6d.; hard, £8 2s. 6d., all per ton.

Scrap.

The outlook in markets for this form of foundry material at the moment is somewhat indefinite, but so far prices show little change, and can hardly be expected to decline lower in the near future. The following are among the latest available in Glasgow market:—Cast-iron machinery scrap, around 65s. to 67s. 6d., in pieces not exceeding 1 cwt.; ordinary heavy quality is 60s. to 61s. Old cast-iron railway chairs keep firm around 67s. 6d. per ton, with little business doing. There is no change in the price of light cast-iron scrap at 53s. 6d. to 54s. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—The opening markets for base metals in the New Year have disclosed a slightly more active tendency, and in the case of warrant copper a rather freer disposition on the part of buyers on forward account. Some further business has been done for India in copper squares and yellow metal, which were quoted £75 and £64 15s. respectively. The American statistics for November had a temporary weakening effect on the market.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £60 17s. 6d. to £60 18s. 9d.; Friday, £60 15s. to £60 16s. 3d.; Monday, £61 1s. 3d. to £61 2s. 6d.; Tuesday, £61 11s. 3d. to £61 12s. 6d.; Wednesday, £61 15s. to £61 16s. 3d.

Three Months: Thursday, £61 to £61 1s. 3d.; Friday, £60 16s. 3d. to £60 17s. 6d.; Monday, £61 to £61 1s. 3d.; Tuesday, £61 10s. to £61 11s. 3d.; Wednesday, £61 15s. to £61 16s. 3d.

Tin.—The markets for standard tin have maintained a fairly steady position on the whole, fluctuations in values having been within moderate compass, seldom varying more than a pound or so in either direction. On the whole, forward metal has been well supported, but trade buying has been rather restricted, professional support playing a part in the resistance to adverse features.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £265 to £265 5s.; Friday, £265 5s. to £265 10s.; Monday, £265 17s. 6d. to £266; Tuesday, £263 10s. to £263 15s.; Wednesday, £258 15s. to £259.

Three Months: Thursday, £261 2s. 6d. to £261 5s.; Friday, £261 5s. to £261 10s.; Monday, £262 5s. to £262 7s. 6d.; Tuesday, £261 5s. to £261 7s. 6d.; Wednesday, £258 5s. to £258 7s. 6d.

Spelter.—In ordinary spelter a very slight improvement has taken place since the holidays. Fluctuations have been within narrow margins, and there is not much evidence of any movement either way. The tone in America does not appear to be good, and probably the half-monthly figures will show a further increase in stocks. Consumption here is on an improved scale, but there is plenty of metal to meet present requirements.

The following are the week's prices:—

Ordinary: Thursday, £26 7s. 6d.; Friday, £26 5s.; Monday, £26 1s. 3d.; Tuesday, £26 2s. 6d.; Wednesday, £26 3s. 9d.

Lead.—A similar movement is noticeable in soft foreign lead, values of which are, if anything, slightly firmer, but the market is very well maintained. The demand from consumers is not very active, but steady support is given to the market by dealers, based on anticipations of an increased demand in the New Year. The position on the Continent is reported healthy, and there have been indications of an improving consumption there, and also in the United States, where refinery stocks have been reduced.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £22 8s. 9d.; Friday, £2 17s. 6d.; Monday, £22 8s. 9d.; Tuesday, £22 5s.; Wednesday, £22 3s. 9d.

DR. G. D. BENGOUGH will deliver a lecture on the subject of "Corrosion, with Special Reference to Standard Tests," at a meeting of the London Local Section of the Institute of Metals, on January 12. The lecture should be of great interest, especially at a moment when the question of standard tests for corrosion is receiving much attention.

World's Output of Iron and Steel in 1926.

The subjoined two tables show, in tons of 2,240 lbs., the world's estimated output of pig-iron and ferro-alloys (Table I), and of steel ingots and castings (Table II) in 1926. The tables are reproduced from the Statistical Summary (Production, Imports and Exports, 1924-1926), relating to the "Mineral Industry of the British Empire and Foreign Countries," recently issued by the Imperial Institute.

TABLE I.—*World's Output of Pig-iron and Ferro-Alloys.*

Producing Countries.	1925.	1926.
BRITISH EMPIRE.	Tons.	Tons
United Kingdom ..	6,261,700	2,458,200
Union of South Africa ..	—	20,060
Canada	596,106	775,457
India	886,602	893,413
Australia	439,419	438,698
Total*	8,185,000	4,590,000
FOREIGN COUNTRIES.		
Austria	373,815	326,305
Belgium	2,501,645	3,344,629
Czecho-Slovakia ..	1,146,871	1,070,449
France (incl. Saar) ..	9,787,301	10,891,753
Germany	9,926,610	9,488,514
Hungary	91,784	186,167
Italy	527,627	549,560
Luxemburg	2,325,272	2,471,197
Netherlands	107,400	††
Norway	86,518	95,747
Poland	309,617	322,256
Rumania	63,240	61,967
Russia†	1,282,660	2,158,240
Spain	521,511	451,896
Sweden	455,125	456,000
United States	36,700,566	39,372,729
Japan	684,923‡	††
Korea	100,295	116,204
Total*	67,600,000	72,800,000
World's total ..	75,800,000	77,400,000

* Including countries not enumerated. † Year ended Sept. 30 ‡ Revised figure. †† Information not yet available.

TABLE II.—*World's Output of Steel Ingots and Castings.*

Producing Countries.	1925.	1926.
BRITISH EMPIRE.	Tons.	Tons.
United Kingdom ..	7,385,400	3,596,100
Union of South Africa ..	36,105§	†
Canada	752,695	776,888
India	449,053	521,753
Australia	398,505	374,287
Total*	9,025,000	5,300,000
FOREIGN COUNTRIES.		
Austria	462,816	466,053
Belgium	2,507,569	3,319,696
Czecho-Slovakia ..	1,500,000	1,550,000
France (incl. Saar) ..	8,876,168	10,000,811
Germany	11,857,441	12,056,725
Hungary	227,425	319,461
Italy	1,756,836	1,750,919
Luxemburg	2,052,712	2,207,662
Poland	779,570	775,871
Russia‡	1,833,844	2,832,591
Spain	615,935	570,724
Sweden	467,482	481,300
United States	45,393,524	48,293,763
Japan	1,314,913¶	†
Total*	79,800,000	86,100,000
World's total ..	88,825,000	91,400,000

* Including countries not enumerated. † Information not yet available. ‡ Year ended Sept. 30. § Including rails, fishplates, etc. ¶ Revised figure.

THE DEATH has taken place of Mr. Enoch Wheeler, of Trinity Street, Old Hill, who had carried on business as an iron and steel merchant for many years. Mr. Wheeler was 54 years of age.

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863.

JAS. DURRANS & SONS, LTD.

PHOENIX WORKS, PENISTONE, near SHEFFIELD.

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Manufacturers of

FOUNDRY EQUIPMENTS

LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS,
CUPOLAS,
GANISTER,
LOAM AND SAND MILLS,
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES,
BUCKETS,
SPADES, Etc.

Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.

GREEN'S EMERGENCY CUPOLA IS A GREAT MONEY SAVER

Sizes from 5 to 40 cwts. capacity per hour.

GREEN'S STEEL CONVERTER PLANTS ARE SECOND TO NONE.

COMPLETE FOUNDRY MELTING EQUIPMENTS
FOR DEALING WITH
CAST IRON, STEEL, and BRASS
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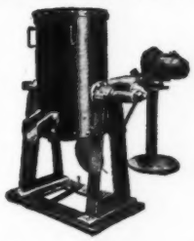

Green's Rapid "Economic" CUPOLA is the last word in Cupola design.

Hundreds of Highly Satisfied Users will confirm this.

Ask for complete Catalogue of Foundry Plant, and file for future reference.

GEORGE GREEN & CO., Foundry Engineers and Contractors KEIGHLEY.

Telegrams : "Cupola." *Telephone : 518.* *Codes : Western Union, Lieber's 5-letter Code, Marconi International.*

CORE OVEN.

THE "PORTWAY"

PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex.

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it.

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director.

Makers—

C. PORTWAY & SON, Tortoise Stove & Portway Portable Oven Works, HALSTEAD, ESSEX.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	61 15 0
Three months	61 15 0
Electrolytic	66 10 0
Tough	65 0 0
Best selected	65 10 0
Sheets	90 0 0
India	75 0 0
Wire bars	67 0 0
Do. January	66 15 0
Do. February	66 15 0
Ingot bars	66 15 0
H.C. Wire rods	70 10 0
Off. av. cash, Dec.	60 2 3
Do. 3 mths., Dec.	60 5 7½
Do., Sttlmnt., Dec.	60 1 10½
Do., Electro, Dec.	66 8 4
Do., B.S., Dec.	65 9 2
Aver. spot price, copper, Dec.	60 2 3
Do., Wire bars, Dec.	66 13 1½
Solid drawn tubes	12¾d.
Brazed tubes	12½d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d
Wire	9½d
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	258 15 0
Three months	258 5 0
English	258 0 0
Bars	264 15 0
Straits	263 15 0
Australian	265 15 0
Eastern	265 10 0
Banca	264 5 0
Off. av. cash, Dec.	267 4 10½
Do., 3 mths., Dec.	263 9 7½
Do., Sttlmt., Dec.	267 4 7½
Aver. spot, Dec.	267 4 10½

SPELTER.

Ordinary	26 3 9
Remelted	26 10 0
Hard	20 10 0
Electro 99.9	31 0 0
English	26 10 0
India	22 5 0
Zinc dust	33 0 0
Zinc ashes	9 0 0
Off. aver., Dec.	26 4 8½
Aver., spot, Dec.	26 7 3

LEAD.

Soft foreign ppt.	22 3 9
English	23 10 0
Off. average, Dec.	22 6 0⅜
Average spot, Dec.	22 3 3

ZINC SHEETS, &c.

Zinc sheets, English	35 0 0
Do. V.M. ex whf.	33 5 0
Rods	42 0 0
Boiler plates	30 10 0
Battery plates	32 0 0

ANTIMONY.

Special brands, Eng.	64 10 0
Chinese	41 10 0
Crude	37 0 0

QUICKSILVER.

Quicksilver	22 7 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	8 17 6
45/50%	12 17 6
75%	21 17 6
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/-lb.
Ferro-titanium—	
23/25% carbonless	11½d
Ferro-phosphorus, 20/25%	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/4 lb.
Tungsten metal powder—	
98/99%	1/8 lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£23 0 0
6/8% car.	£22 17 6
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£35 17 6
Max. 1% car	£41 12 6
Max. 0.70% car	£52 0 0
70% carbonless	1/4 lb.
Nickel—99% cubes or pellets	£170 0 0 to £175 0 0
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	2/11 lb.
Ferro-manganese (net)—	
76/80%, loose	£13 10 0
76/80%, packed	£14 10 0
76/80%, export	£12 10 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 6
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.
South Wales—	
Hvy. steel	3 0 0 to 3 2 6
Bundled steel and shrngs.	2 13 6 to 2 18 6
Mixed iron and steel	2 13 6 to 2 15 0
Heavy cast iron	2 18 0 to 2 19 0
Good machinery for foundries	3 0 0 to 3 2 6
Cleveland—	
Heavy steel	2 15 0
Steel turnings	2 6 0
Cast iron borings	2 3 0
Heavy forge	3 12 6
Bushelled scrap	3 2 6
Cast-iron scrap	3 2 6 to 3 6 0
Lancashire—	
Cast-iron scrap	3 5 0
Hvy. wrought	3 2 6
Steel turnings	2 2 6
London—Merchants' buying prices delivered yard.	
Copper (clean)	51 0 0
Brass (clean)	38 10 0
Lead (less usual draft)	19 10 0
Tea lead	16 10 0
Zinc	17 0 0
New aluminium cuttings	76 0 0
Braziery copper	47 0 0
Gunmetal	48 0 0
Hollow pewter	170 0 0
Shaped black pewter	130 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	67/6
Foundry No. 3	65/-
Foundry No. 4	64/-
Forge No. 4	63/6
Hematite No. 1	71/6
Hematite M/Nos.	71/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/-
,, d/d Birm.	89/- to 90/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	62/6
,, No. 3 fdry.	64/6 to 65/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	54/-
,, fdry. No. 3	58/6 to 59/6
Derbyshire forge	60/-
,, fdry. No. 3	64/- to 65/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	70/6
Hem. M/Nos.	74/6
Sheffield (d/d district)—	
Derby forge	65/-
,, fdry. No. 3	68/-
Lincs. forge	65/-
,, fdry. No. 3	68/-
E.C. hematite	84/6
W.C. hematite	89/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	73/3
Northants foundry No. 3	—
Dalzell, No. 3	100/- to 102/6
Summerlee, No. 3	88/- to 94/-
Glengarnock, No. 3	88/- to 94/-
Gartsherrie, No. 3	88/- to 94/-
Monkland, No. 3	88/- to 94/-
Coltness, No. 3	88/- to 94/-
Shotts, No. 3	88/- to 94/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	9 15 0	to 10 15 0
Angles		—
Tees to 3 united ins.		—
Nut and bolt iron		9 0 0
Hoops		12 10 0
Marked bars (Staffs.) f.o.t.		12 10 0
Gas strip		12 0 0
Bolts and nuts, ¾ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 2 6	to 8 7 6
Boiler plts.		10 10 0
Chequer plts.		10 5 0
Angles		7 12 6
Tees		8 12 6
Joists		7 12 6
Rounds and squares, 3 in. to 5½ in.		7 15 0
Rounds under 3 in. to ⅜ in. (Untested)		8 0 0 and upwards
Flats, over 5i n. wide and up		9 2 6
Flats, 5 in. to 1½ in.		8 2 6
Rails, heavy	8 2 6	to 8 7 6
Fishplates		12 10 0
Hoops (Staffs.)		10 10 0
Black sheets, 24g.		10 2 6
Galv. cor. shts., 24g.		13 0 0
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	£6 0 0	to 6 10 0
Billets, hard		8 2 6
Sheet bars	£5 12 6	to 5 15 0
Tin bars	£5 12 6	to 5 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3¾
Rods	1 3
Tubes	1 8½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	19.76
No. 2 foundry, Valley	17.25
No. 2 foundry, Birm.	16.00
Basic	18.76
Bessemer	19.26
Malleable	18.26
Grey forge	18.51
Ferro-mang. 80% d/d	100.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.20
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.65
Sheets, blue an'l'd., 9 and 10	2.10
Wire nails	2.50
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplate, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	13/6
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/3
,,	28×20 ,,	36/6
,,	20×10 ,,	—
,,	18¾×14 ,,	—
C.W.	20×14 ,,	17/4½
,,	28×20 ,,	—
,,	20×10 ,,	—
,,	18¾×14 ,,	—
Terneplates	28×20 —	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£18 10 0 to 19 0 0
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	45%
Water	63½%	40%
Steam	60%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Dec.	29	60	17	6	No change
,,	30	60	15	0	dec. 2/6
Jan.	2	61	1	3	inc. 6/3
,,	3	61	11	3	,, 10/-
,,	4	61	15	0	,, 3/9

Electrolytic Copper.

		£	s.	d.	
Dec.	29	66	10	0	No change
,,	30	66	10	0	,, ,,
Jan.	2	66	10	0	,, ,,
,,	3	66	10	0	,, ,,
,,	4	66	10	0	,, ,,

Standard Tin (cash).

		£	s.	d.	
Dec.	29	265	0	0	dec. 20/-
,,	30	265	5	0	inc. 5/-
Jan.	2	265	17	6	,, 12/6
,,	3	263	10	0	dec. 47/6
,,	4	258	15	0	,, 95/-

Tin (English ingots).

		£	s.	d.	
Dec.	29	263	5	0	dec. 35/-
,,	30	263	5	0	No change
Jan.	2	264	0	0	inc. 15/-
,,	3	262	15	0	dec. 25/-
,,	4	258	0	0	,, 95/-

Zinc Sheets (English).

		£	s.	d.	
Dec.	29	35	0	0	No change
,,	30	35	0	0	,, ,,
Jan.	2	35	0	0	,, ,,
,,	3	35	0	0	,, ,,
,,	4	35	0	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
Dec.	29	26	7	6	No change
,,	30	26	5	0	dec. 2/6
Jan.	2	26	1	3	,, 3/9
,,	3	26	2	6	inc. 1/3
,,	4	26	3	9	,, 1/3

Lead (English).

		£	s.	d.	
Dec.	29	23	15	0	inc. 5/-
,,	30	24	0	0	,, ,,
Jan.	2	23	15	0	dec. 5/-
,,	3	23	15	0	No change
,,	4	23	10	0	dec. 5/-

AVERAGE PRICES OF GALVANISED CORRUGATED SHEETS (NORTH OF ENGLAND).

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901.....	13 0 0	12 5 0	11 10 0	11 16 0	11 10 0	11 10 0	11 10 0	11 10 0	12 0 0	12 0 0	12 0 0	12 0 0	11 17 1
1902.....	12 0 0	11 10 0	11 10 0	11 10 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 14 2
1903.....	11 5 0	11 5 0	11 5 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 7 1
1904.....	11 5 0	11 5 0	11 5 0	11 5 0	10 15 0	10 15 0	10 15 0	10 15 0	10 5 0	10 5 0	10 5 0	10 5 0	10 15 0
1905.....	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	11 0 0	11 5 0	11 15 0	12 0 0	10 15 0
1906.....	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 12 6	12 12 6	12 15 0	12 15 0	12 15 0	13 5 0	12 12 11½
1907.....	13 5 0	13 5 0	13 15 0	13 15 0	13 15 0	13 15 0	13 17 6	13 17 6	13 17 6	13 2 6	13 2 6	13 2 6	13 10 10
1908.....	13 2 6	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 11 0½
1909.....	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 16 8
1910.....	11 15 0	12 5 0	12 5 0	11 15 0	11 10 0	11 10 0	11 12 6	11 12 6	11 12 6	11 12 6	11 10 0	11 10 0	11 13 4
1911.....	11 5 0	11 1 3	10 15 0	10 15 0	10 13 9	10 10 0	10 13 9	11 0 0	11 5 0	11 5 0	11 5 0	11 7 0	10 19 7½
1912.....	11 10 0	11 10 0	11 10 0	11 15 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 12 6	12 18 0	12 15 0	12 2 11½
1913.....	12 15 0	12 15 0	12 15 0	12 11 3	11 18 0	11 15 0	11 15 0	11 15 0	11 15 0	11 3 0	11 0 0	11 2 6	11 18 4
1914.....	11 7 0	11 7 6	11 7 6	11 5 7½	11 2 6	10 15 0	10 15 0	12 17 6	14 2 0	13 7 0	11 15 7	11 2 6	11 16 0
1915.....	11 10 8½	13 12 6	14 8 9	15 0 6	17 17 6	20 17 6	20 17 6	20 6 3	17 12 6	18 1 0	22 13 9	25 2 0	18 3 4½
1916.....	26 5 0	27 12 6	28 0 0	28 5 0	29 0 0	29 0 0	28 15 0	28 3 0	28 15 0	28 15 0	28 15 0	28 15 0	28 6 8½
1917.....	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 0 0	28 0 0	28 0 0	28 11 3
1918.....	28 5 0	28 15 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	28 13 4
1919.....	29 0 0	29 0 0	29 0 0	28 0 0	28 10 0	27 7 6	27 5 0	29 3 0	32 0 0	33 0 0	36 10 0	40 8 4	31 5 3½
1920.....	46 10 0	49 15 0	53 15 0	56 0 0	55 10 0	54 10 0	52 10 0	48 10 0	44 3 4	39 2 6	35 17 6	30 8 0	47 4 3
1921.....	28 10 0	25 17 6	24 5 0	23 3 4	22 0 0	22 0 0	23 10 0	21 12 6	20 0 0	18 15 0	18 3 9	17 2 0	22 1 7
1922.....	16 17 6	15 13 9	16 3 0	16 10 0	16 4 4½	15 15 6	15 16 3	16 16 0	16 8 9	16 6 3	17 1 0	17 7 6	16 7 5½
1923.....	18 3 1½	19 1 11½	19 8 0	19 10 0	19 7 0	19 1 3	18 0 0	18 13 1½	19 0 0	19 3 9	19 2 6	18 19 4½	18 19 2
1924.....	18 13 6	18 9 4½	18 5 0	17 15 11½	17 3 0	17 19 4½	18 7 6	18 8 1½	18 8 1½	17 19 6	17 11 3	17 10 0	18 0 10½
1925.....	17 8 6	17 1 6½	16 9 4½	16 12 0	16 9 8½	16 9 4½	16 0 6	16 1 10½	16 5 0	16 7 0	16 12 6	6 15 0	16 11 0½
1926.....	16 14 4½	16 5 7½	16 0 6	15 11 10½	15 11 3	16 0 0	16 16 0	16 18 9	16 14 0	16 18 9	17 10 0	6 19 0	16 10 0½
1927.....	16 3 1½	15 7 6	15 3 3	15 3 1½	14 14 4½	14 11 6	14 1 10½	14 0 0	13 19 6	13 16 10½	13 13 1½	13 3 9	14 9 10

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
ROYAL BLDS., FISHER ST., SWANSEA.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
20, SECOND LINE BEACH, MADRAS.
1, HONG KONG ROAD, SHANGHAI.

REGISTERED TRADE MARK

OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON
NADIR HOUSE, MACLEOD ROAD, KARACHI.
1 SHAREH SONK EL TEWFIKIEH, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

FOUNDRY MANAGER OR FOREMAN.—Wanted, a position in Heavy and Light Engineering or General Jobbing; loam, dry sand, green sand, plate and machine moulding; 20 years' experience; highest references; mixing of metals; member of I.B.F.—Box 538, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER or FOREMAN desires position; 20 years' experience in heavy and light, loam, dry sand and green sand, condensing plants, Uniflow and Diesel engines and machine tools; highest references. Box 560, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MOULDER.—Assistant Foreman required for Steel Foundry with Siemens-Martin Acid Steel Furnaces; must have had first-class experience in medium weight and light castings, including Turbine and Valve Castings; also experienced in modern Machine Moulding practice.—Apply, stating full particulars of experience and age, to "Moulder," WM. PORTEOUS & COMPANY, Advertising Agents, Glasgow.

WANTED, experienced Iron Moulders, accustomed to heavy ornamental castings.—Apply, Box 562, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

UNDER-FOREMAN wanted for Iron Foundry in Yorkshire, with weekly output of 150 tons in loam, dry and green sand castings. Applicants must have thorough knowledge up-to-date Foundry practice, including machine moulding; splendid opportunity for energetic young man with necessary qualifications.—State age, experience and salary required, Box 564, Offices of the FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENCIES.

AGENT wanted; Sale of all classes Foundry Pig-iron; must have good connection throughout Midland district; only experienced man considered.—Apply, stating terms and references, to Box 566, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENTS ON COMMISSION, OR DISTRIBUTORS, wanted, all parts, calling on Foundries, for the Sale of "Metallic Phosphoro."—Write CHAS. HALL, 746, Seventh Street, Buffalo, N.Y., U.S.A.

PROPERTY.

11 ACRES WORKS SITE—SHEFFIELD. 145,000 sq. ft. of SHOPPING, compact and convenient. Siding connections with L.M. & S. and L. & N.E. Rlys. Well-built and commodious Offices. Will sell whole or in lots to suit customers, or let on favourable terms. Unique opportunity for manufacturers.

Apply,

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

PATENTS AND TRADE MARKS.

INFORMATION HANDBOOKS, Advice, and Cons. free; King's Patent Agency, Ltd.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146A, Queen Victoria Street, E.C.4. 40 years' refs. 'Phone: 0682 Central.

TENDERS.

ARMY CONTRACTS.

Notice is hereby given that tenders for quantities of the undermentioned manufactured goods are invited from time to time as required:—

Metal Trades, etc.

Aluminium Castings and Pressings, Bedsteads, Cutlery, Copperware; Enamelled Ware, Fencing (woven wire and strained iron wire), Field Forges, Hollow-ware, Lamps and Lanterns, Nails, Saddletrees, Safety Razors and Blades, Sash Chains, Scratch Card, Screws, Shovels Stoves, Grates, etc., Telegraph Poles (Iron), Tinplates, Tinware, Tools, Tubing, Wire.

Textile Trades, etc.

American Cloth, Metal Badges and Buttons, Blankets, Braids, Jute Buckram, Canvas and Canvas Goods, Cloth, Cordage, Cottons and Cotton Goods, Cotton Waste, Cotton Waste for Guncotton, Elastic Webbing, Embroidery, Flags, Flannel, Head-dresses (including Bearskin Caps), Hessian, Horse Rugs, Hosiery (including Hose Tops), Lasting Cloth, Linens and Linen Goods, Moquette, Puttees, Sewing Cotton and Thread, Silk, Sponge Cloths, Stockinette Tapes, Tents, Turkish Towels, Uniform Clothing (made up from Department's own materials), Webs, Woollen Drawers and Jerseys, Worsted Gloves.

Electrical and Scientific Instrument Trades.

Cables, Electrical Stores, Scientific Instruments.

General Trades.

Acid-Resisting Stoneware, Boots and Shoes, Boxes and Chests, Brushes and Brooms, Candles, Chemicals (including Acetone, Alcohol, Aluminium Powder, Anhydrous Ammonia, Barium Nitrate, Magnesium Powder, Soda), Chinaware, Cocoanut Shell, Combs, Cooperage, Earthenware, Furniture, Glassware and Splinterless Glass, India-rubber Goods, Leather Goods, Paint (including Vermilion and Zinc Oxide, Dry), Palm Nut Shell, Powdered Ivory Nut, Soap, Stable Fitments, Timber, Vehicles Woodware.

Manufacturers who are not already on any War Office List of Tenderers, and who may wish to be invited to tender for Army requirements of the above stores, should apply to the Director of Army Contracts at the address given below for Form 1, on which formal application for inclusion on the list of tenderers may be made. The services of an intermediary are unnecessary in approaching the Department for this purpose.

Before being placed on the lists of tenderers, firms will have to satisfy the Department that they actually manufacture goods for which they wish to be noted, and will be required to furnish the names of at least two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions. They will further have to give an undertaking that they will comply with the Fair Wages Resolution of the House of Commons.

Attention is called to the following resolution passed by both Houses of Parliament on February 16, 1926:—

"That in the opinion of this House, it is the duty of the Government in all Government contracts to make provision for the employment to the fullest possible extent of disabled ex-service men, and to this end to confine such contracts, save in exceptional circumstances, to employers enrolled on the King's National Roll."

Sales

From time to time the Department has for sale surplus army stores of various descriptions, among which may be mentioned Machinery, Steel Girder Bridges, Electrical Stores, Hutting, Mechanical Transport, Drugs, Medical and Dental Stores, Veterinary Stores, Laboratory Apparatus, Clothing, Textiles, Scrap Metals. Firms who wish to be invited to tender for the purchase of surplus stores should apply as directed below.

All applications should be in writing, and should be addressed to The Director of Army Contracts, Caxton House (West), Tothill Street, Westminster, London, S.W.1. No application is necessary from firms whose names are already on the War Office lists, unless they have extended the range of their manufactures.

N. F. B. OSBORN,
Director of Army Contracts.

MACHINERY.

MACHINERY PLANT, &c., FOR SALE.

Vertical Belt-driven AIR COMPRESSOR, series BD, size No. 5, two cyls., 16-in. diam. x 12-in. stroke, by Alley & McLellan.

Horizontal Belt-driven AIR COMPRESSOR, class N.E.1, 12¼-in. cyl. x 12-in. stroke, capacity 310 cub. ft. per min., by Holman Bros.

100-h.p. MARSHALL COUPLED VERTICAL ENGINE.

HYDRAULIC ACCUMULATOR, with 9¾-in. ram, 10-ft. stroke, 700-lbs. working pressure, base 3-ft. 6-in. diam.

2-ft. gauge PETROL LOCOMOTIVES ("Simplex" and McEwan Pratt), 10/12-h.p. and 20-h.p.

5-ton ELECTRIC GOLIATH CRANE (Russell), about 53-ft. span, 17-ft. lift, three motor type, 480 volts D.C.

One good second-hand BABCOCK WATER TUBE BOILER of 4,356 ft. of heating surface, reinsurable at a working pressure of 150 lbs. per sq. in., with chain grate stoker, etc.

NEARLY NEW LANCASHIRE BOILER, 30 ft. x 9 ft., reinsure at 100-lbs. working pressure, complete with steam and furnace fittings, etc.

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD.

'Phone 98 Staines.

Vertical Air Compressor, belt driven, 60-lbs. pressure, 150 c.f. Also 4-cyl. Reavell, cyls. 5½ x 5½.

Cochran Waste Heat Boiler, 17 ft. 6 in. x 7 ft., 100-lbs. w.p.

Three-throw Plunger Pump, 5½ in. x 8 in.

4-ft. 6-in. Under-driven Sand Mill.

Horizontal Double Cylinder Steam Winch, 4½ in. x 6 in.

HARRY H. GARDAM & COMPANY, LIMITED, Staines.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

MISCELLANEOUS.

MAUGHLIN PATTERN LETTERS AND FIGURES.—Die cast complete with pins in one piece, ready for fixing; no shellac required; simply drive them in and they will not come off; send for samples and prices.—A. LAKIN & SON, Totley Rise, Sheffield.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. BUCHANAN & COMPANY, Ashfield Road, Altrincham, Cheshire.

PARTING POWDER.—Have you tried ours? Efficient and cheap.—WM. OLSEN, LTD., Cogan Street, Hull.

'Phone: 287 SLOUGH.

CRANE LADLES

½ TON (NEW), enclosed gear	.. £12
1 TON (NEW), enclosed gear	.. £20
3 TON EVANS, as new	.. .. £30
5 TON EVANS, as new	.. .. £36
8 TON EVANS, good	.. .. £40
10 TON STEVENSON, equal to new	£45
12 TON EVANS, equal to new	.. £65

All have Worm and Bevel Gear.

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS.

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH.